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Editorial

The economic impact due to COVID-19 pandemic in India has been largely disrupting and alarming. Growth in the fourth quarter of the financial year 2020 in India went down to 3.1 per cent. Notably India had also been witnessing a pre-pandemic slowdown, and according to the World Bank, the current pandemic has "magnified pre-existing risks to India's economic outlook". The World Bank and rating agencies had initially revised growth for FY2021 with the lowest figures since India's economic liberalization. However, after the announcement of the economic package in mid-May, GDP estimates were downgraded even more to negative figures, signalling a deep recession. State Bank of India research estimates a contraction of over 40 per cent in the GDP in Q1 FY21. The contraction will not be uniform, rather it will differ according to various parameters such as state and sector. Within a month, unemployment rose from 6.7 per cent on 15 March to 26 per cent on 19 April. During the lockdown, an estimated 14 crore people have lost employment. More than 45 per cent of households across the nation have reported drop in income as compared to the previous year. The Indian economy was expected to lose over ₹ 32,000 crore every day during the first 21-days of complete lockdown. Up to 53 per cent of businesses in the country were projected to be significantly affected. Supply chains have been put under stress with the lockdown restrictions in place; initially, there was a lack of clarity in defining essential commodities. At the same time those in the informal sectors and daily wage groups have been at the most risk. A large number of farmers around the country who grow perishables also faced uncertainty due to closure in the supply chain. Major companies in India have temporarily suspended or significantly reduced operations. Fast-moving consumer goods companies in the country have significantly reduced operations and are focusing on essentials. The Government of India has announced a variety of measures to tackle the situation, from food security and extra funds for healthcare and for the states, to sector related incentives and tax deadline extensions. The different phases of India's lockdown up to the "first unlock" on 1 June had varying degrees of the opening of the economy. On 17 April, 2020 the Governor of RBI announced more measures to counter the economic impact of the pandemic including ₹ 50,000 crore special assistants to different agencies. On 12 May Government of India has also announced an overall economic package worth ₹ 20 lakh crore, which is 10 per cent of GDP, with emphasis on India as a self-reliant nation. Therefore, there is a big challenge to India in the coming days to fight against the economic crisis which was largely disrupted due to COVID-19 pandemic all over the world.

Debashis Sarkar

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Editor-in-Chief

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Resource Use Efficiency of Rice Farmers Participating in Value Chain Development Programme (VCDP) in Niger State of Nigeria

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ABSTRACT

The research empirically determined the efficiency of the productive resources used in rice production among IFAD beneficiaries in Niger State of Nigeria using field survey data of 2018 production season elicited from 111 farmers through structured questionnaire complemented with interview schedule and the representative sample size was arrived at through multi-stage sampling design. The multiple regression model which adopted ordinary least square (OLS) estimation technique was used to analyze the data collected. The empirical findings showed that the farmers were operating within the economic region of production but were not at the economic optimum point owing to inefficiency in the utilization of the available recommended technologies at their disposal coupled with market imperfections. Thus, sequel to this, the study recommends the need for capacity building for the farmers on the recommended technologies *viz.* efficient extension services delivery (e.g. farmers field school) and adoption of neo-classical extension approach (farmer to farmer extension approach). In addition, provisions of consumption credit apart from the advanced production credit for the productivity of the latter and agro-inputs subsidies due to the farmers' poor economic status and the prevailing market imperfections are suggested in the studied area.

Highlights

- Farmers were not efficient in the utilization of the farm resources at their disposal given the available technology.
- There is need for capacity building so as to enhance productivity of rice in the studied area.

Keywords: Resource, productivity, IFAD/VCDP, rice farmers, Nigeria

It has been reported by Babatunde (2006) that especially in the developing countries such as Nigeria, the concern over the alarming rate of poverty level and the need for its alleviation as a means of enhancing the living standard of the people has led to the conceptualization and implementation of various poverty alleviation programmes worldwide among which International Fund for Agricultural Development (IFAD) was initiated. Rapid agricultural growth still remains the surest and possible way to poverty reduction in Nigeria. The IFAD support to the Nigerian Government's poverty reduction programme in rural areas is essentially people-centered with its target groups being the share labourers, landless, marginal and small-scale farmers who major in the sub-Saharan farming population (IFAD, 2013). Thus,

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the IFAD supports programmes and projects that work with the communities and the smallholder farmers are the key players.

The prime motives of IFAD/VCDP programme are to enhance the food security of the food supplying population i.e. the rural population especially the resource-poor farmers; the food demanding population especially the urban population; and enhance the living standard of the targeted population especially the landless, marginal and small-scale farmers through income doubling by encouraging them to take advantage of value addition i.e. additional non-farm activities. The programme is anchored on technical support, linking farmers with input and output markets to achieve their set goals. Given the economic status of the targeted population which are mostly share labourers, landless, marginal and small-scale farmers which are resource poor, the achievement of the goals of the programme is in doubt as these categories of farmers are less likely to make a paradigm shift in their scale of production as their experiences on previous programmes makes it difficult for them to delineate totally from the conventional available technology at their disposal. From empirical observation, the yield of the participating farmers in the study area has been below the recommended output level of 7 to 8 tons. Therefore, since the farmers did not have the passion to delineate totally from the existing conventional technology available at their disposal, therefore, an alternative which will build on the already existing available technology need to be advanced in order to make the programme a success in reality, thus exiting the farmers from the economic status of resource poor. In addition, the pitfall is that most of the empirical studies on food security programmes for sub-Saharan Africa mostly abstract the programme success from the macro level to the micro level instead of the reverse situation i.e. mostly concentrate on the effect and impact of the programme on farmers income (for example Galadima 2014; Abdullahi *et al*. 2015; Gambo *et al*. 2016) when it is well known that productivity has a direct link with income. Thus, productivity still remains a thrust that requires tacit exploitation given the penchant conservative attitudes of the bulk of the farming population (small-scale farmers) in retaining the existing conventional production technology at their disposal. Based on literature reviews, to the best of our knowledge, there is little or no information on how to build on the technical capacity of the rice farmers to enable them bridge and even surpass the recommended yield level benchmarked by IFAD programme in Niger State of Nigeria. Therefore, this research aimed at determining the resource productivity of rice farmers participating in IFAD/VCD programme in Niger State of Nigeria.

The outcome of this research will be of immense benefit as it will aid in guiding policymakers on how to make an adjustment at the farm production level which is very vital to the viability of the rural economy which inturn is indispensable to economic growth and development of Niger State in particular and the country at large. In addition, it will add to the advancement of knowledge and a basis to explore further on by the researchers especially on IFAD programme in the study area. However, the research suggests that future studies should look into the symmetric and asymmetric effects of risks and idiosyncratic factors causing yield gap among the participating farmers as the present research limited its scope to production inputs.

RESEARCH METHODOLOGY

The location of Niger state is on latitudes 8°20′N and 11°30′N of the equator and longitudes 3°30′E and 7°20′E of the GMT. The agro-ecological zone of the state is northern guinea savannah with a fringe of southern guinea savannah in Mokwa LGA. The major occupation of the inhabitants is farming and it's complemented with civil service jobs, artisanal, craftwork, *Ayurveda* medicines and petty trade. By using a structured questionnaire complemented with interview schedule, field survey data of 2018 cropping season were elicited from a total of 111 rice farmers sampled through a multi-stage sampling design. In the state, only five (5) Local Government Areas were chosen as the pilot phase for the programme with Agricultural Zone A (Bida) and C (Kontagora) having two LGAs each namely Bida and Katcha; and, Wushishi and Kontagora respectively, while Zone B has one participating LGA *viz.* Shiroro. In the first stage, for Agricultural Zone A, one LGA *viz.* Katcha LGA was randomly selected; for Zone B the only participating LGA *viz.* Shiroro LGA was automatically selected; while for

Zone C, Wushishi LGA was purposively selected based on its comparative advantage as rice is produce throughout the year owing to the presence of Tungan Kawo irrigation dam. In the second stage, two villages were randomly selected from each of the chosen participating LGAs. Thereafter, two active co-operative associations from each of the selected villages were randomly selected. It is worth to note that Microsoft excel inbuilt random sampling mechanism was used for the random selections of the villages and the co-operative associations. In the last stage, using the sampling frame obtained from the IFAD/VCD office (Table 1), Cochran's formula was used to determine the representative sample size. Thus, a total of 111 active rice farmers form the sample size for the study. The multiple regression model using OLS estimation technique was used to analyze the data collected. The Cochran's formula used is shown below:

$$n_\alpha = \frac{n_r}{1 + \frac{(n_r - 1)}{N}} \qquad \ldots(1)$$

$$n_r = \frac{(1.96)^2\, pq}{e^2} \qquad \ldots(1\text{A})$$

Where:

n_α = adjusted sample size for finite population

n_r = sample size for infinite population

N = population size

p = proportion of population having a particular characteristic

$q = 1 - \mathrm{p}$

e^2 = error gap (0.07)

Thus, $p = 0.40$ and $q = 1 - 0.40 = 0.60$

Model Specification

The multiple regression model is presented below:

Implicit form

$$Y = f(X_1, X_2, X_3, X_4 \ldots\ldots, X_n) \qquad \ldots(2)$$

Explicit form

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots\ldots + \beta_n X_n + \varepsilon_i \qquad \ldots(3)$$

Where;

Y = Output of rice (kg)

X_1 = Farm size (ha)

X_2 = Seeds (kg)

X_3 = NPK fertilizer (kg)

X_4 = Urea fertilizer (kg)

X_5 = Herbicides (ltr)

X_6 = family labour

X_1 = Paid labour (manday)

X_8 = depreciation on capital items (₦)

β_0 = Intercept

β_{1-8} = Regression coefficients

ε_t = Stochastic

Table 1: Sampling frame of participating and non-participating farmers

LGAs	Villages	Co-operative Associations	SF	SS
Katcha	Baddegi	Managi Badeggi Farmers CMPS	24	10
		Aminci Ebanti Twaki CMPS Ltd.	25	10
	Edostu	Edotsu Co-Operative Credit & Marketing CMPS	25	10
		Edotsu Jinjin Wugakun Yema CMPS	25	10
Shiroro	Baha	Baha Abmajezhin Cooperative Multi-Purpose Society Ltd.	15	7
		Abwanubo Najeyi Development Association	18	8
	Paigado	Paigado Achajebwa Development Farmers Soc.	25	10
		Paigado Farmers Cooperative Society Ltd.	25	10
Wushishi	Bankogi	Bankogi Alheri Farmers Coop. Multipurpose Soc Ltd.	22	9
		Bankogi Gwari Nasara CMPS	16	7
	Kanko	Kanko Arewa Farmers	25	10
		Kanko Unguwar Ndakogi Cooperative Multipurpose Society Ltd.	25	10
Total			**270**	**111**

Source: *IFAD-VCDP farmers' database, 2018.*

Note: *SF and SS mean sampling frame and sample size respectively.*

The functional forms fitted into the specified equation are as follow:

(a) Linear function

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots + \beta_n X_n + \varepsilon_t \quad \ldots(4)$$

$MPP = \beta$

$Elasticity = \beta * \overline{X} / \overline{Y}$

(b) Semi–log function

$$Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 \ldots\ldots\ldots\ldots + \beta_n \log X_n + \varepsilon_t \quad \ldots(5)$$

$MPP = \beta / \overline{X}$

$Elasticity = \beta / \overline{Y}$

(c) The Cobb Douglas (double log) function

$$\log Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 \ldots \ldots \ldots\ldots\ldots + \beta_n \log X_n + \varepsilon_t \quad \ldots(6)$$

$MPP = \beta * \overline{X} / \overline{Y}$

$Elasticity = \beta$

(d) Exponential function

$$\log Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots\ldots + \beta_n X_n + \varepsilon_t \quad \ldots(7)$$

$MPP = \beta * \overline{Y}$

$Elasticity = \beta * \overline{X}$

Determining technical efficiency of resource use

The elasticity of production was used to estimate the rate of return to scale which is a measure of a firm's success in producing maximum output from a set of variable inputs.

$$EP = (MPP) / APP \quad \ldots(8)$$

Where:

EP = elasticity of production

MPP = marginal physical product

APP = average physical product

If,

EP = 1: constant return to scale

EP < 1: decreasing return to scale

EP > 1: increasing return to scale

Marginal rate of technical substitution (MRTS)

Following Dawson and Lingard (1982); Hussain (2013); and Sadiq *et al*. (2018), the MRTS approach adopted is given below:

$$MRTS_{L/C} = \beta_L / \beta_C \;\; XCL^{-1} \quad \ldots(9)$$

Where $MRTS_{L/C}$ represents marginal rate of substitution of input L for C, where β_L is the output elasticity of L and β_C is the output elasticity of C.

Determining the allocative efficiency of resource-use

The following ratio was used to estimate the relative efficiency of resource use (r):

$$AEI = MVP / MFC \quad \ldots(10)$$

Where:

MFC or P_x = unit cost of a particular resource

MVP = value added to rice output due to the use of an additional unit of input, calculated by multiplying the MPP by the unit price of output i.e. $MPPx_i * P_y$.

Rule of Thumb

If r = 1, resource is efficiently utilized

If r > 1, resource is underutilized

If r < 1, resource is over-utilized

Economic optimum takes place where $MVP = MFC$. If AEI is not equal to 1, it suggests that resources are not efficiently utilized. Adjustments could therefore be made in the quantity of inputs used and costs in the production process to restore $r = 1$ and the model is given as follows:

Divergence percentage (D %) =

$$\left(1 - 1/r_i\right) \times 100 \text{ or } \left[\frac{\left(r_i - 1\right)}{r_i}\right] \times 100 \quad \ldots(11)$$

RESULTS AND DISCUSSION

Production efficiency of the rice farmers in the study area

The OLS estimation results of the four functional forms fitted into the specified production equation showed the linear regression to be the best fit as it satisfied all the needed conditions *viz*. economic (i.e. size and signs of the parameter estimates), statistical (i.e. the standard error and the coefficient of multiple determination) and econometric criteria (the OLS assumptions), thus chosen as the lead equation (Table 2). The diagnostic test results showed the residuals not to be normally distributed as evident by the significance of the Chi^2 test at 10% degree of freedom. However, literature has shown that violation of normality assumption should not be considered a serious case as data in their natural form are not normally distributed. Furthermore, it was observed that there are no problems of heteroscedasticity and multicollinearity as indicated by the non-significance of the Breusch-Pegan LM test at 10% degree of freedom and the values of the predictor variables which were lower than the variance inflation factor (VIF) value of 10.0, respectively. However, the non-fit functional forms passed the residual test of normality (two functional forms) and multicollinearity but failed the test of homoscedasticity which is very important as its violation will make the least squares not reliable for prediction, thus their non-reliability for future prediction.

The observed coefficient of multiple determination (R^2) value is 0.728, implying that 72.8% of the variation in the rice output of the farmers was explained by the controlled variables included in the model. In addition, the significance of the F-statistics at 1% degree of freedom implies that the explanatory variables have a strong influence on the explained variable and also from the population point of view the inputs have a strong influence on the rice output. A cursory review of the results showed only size of the operational holding, NPK fertilizer and human labour to have a significant influence on the rice output as their respective estimated parameters were different from zero at

Table 2: Production determinants of rice output among IFAD beneficiaries

Inputs	**Ordinary least square (OLS)**				**Col. Test**
	Linear (+)	**Exponential**	**Semi-log**	**Double log**	**VIF (+)**
Constant	106.127(380.503) [0.2789]^{NS}	7.584 (0.0721) [105.2]***	−9553.19 (3611.59) [2.645]**	6.188 (0.617) [10.04]***	—
Farm size	1475.41 (438.83) [3.362]***	0.292 (0.0831) [3.516]***	2109.97 (677.51) [3.11]***	0.435 (0.116) [3.760]***	3.988
Seeds	3.98472 (2.28357) [1.2134]^{NS}	0.00048 (0.001) [0.481]^{NS}	331.64 (321.99) [1.030]^{NS}	0.054 (0.055) [0.978]^{NS}	2.817
NPK	6.0322(2.0268) [2.976]***	0.0011 (0.00038) [2.927]***	1117.24 (479.31) [2.33]**	0.214 (0.082) [2.618]**	3.039
Urea	2.05026(1.9673) [1.045]^{NS}	0.00042 (0.00075) [0.555]^{NS}	839.34 (516.13) [1.62]^{NS}	0.120 (0.088) [1.362]^{NS}	3.413
Herbicides	28.129(81.0175) [0.347]^{NS}	0.00818 (0.0153) [0.533]^{NS}	582.72 (473.85) [1.23]^{NS}	0.083 (0.081) [1.020]^{NS}	2.526
Family labour	7.4674(2.8184) [2.649]***	0.00057 (0.00053) [1.074]^{NS}	144.91 (163.02) [0.89]^{NS}	0.018 (0.028) [0.649]^{NS}	2.483
Paid labour	6.6226(3.588) [1.846]*	0.00069 (0.00068) [1.016]^{NS}	105.21 (156.26) [0.67]^{NS}	0.002 (0.027) [0.074]^{NS}	1.266
Depreciation on capital items	−0.01606(0.0149) [1.142]^{NS}	−2.842E-6 (1.31E-5) [0.216]^{NS}	96.48 (288.22) [0.33]^{NS}	−0.0011 (0.049) [0.022]^{NS}	2.288
Σβ	**0.98**				
R^2	**0.728**	**0.680**	**0.660**	**0.675**	
Adjusted R^2	0.706	0.655	0.633	0.649	
F-stat	**33.74*** **	**26.80*** **	**24.47*** **	**26.20*** **	
Heteroskedasticity (B-G)	**2.645{0.234}**^{NS}	**80.61{0.0006}*** **	**77.53{1.5E-13}*** **	**52.20{1.5E-8}*** **	
Normality test	**13.16{0.0013}*** **	**3.865{0.144}**^{NS}	17.40{0.00016}***	3.07{0.214}^{NS}	

Source: *Field survey, 2018.*

Note: ** ** *** ^{NS} significance at 1%, 5%, 10% and Non-significant respectively.*

Values in ( ); [ ]; and { } are standard error, t-statistic and probability value, while Col. = Collinearity

10% degree of freedom as against others whose parameter estimates were not different from zero at 10% degree of freedom. The positive significance of farm size revealed the effects of economies of scale and land productivity in increasing rice output among the IFAD farmers. Thus, the marginal and elasticity implications of a unit increase in the rice operational holding by 1 hectare will lead to an increase in rice output by 1475.41kg and 0.41% respectively. The positive significance of the NPK fertilizer indicates the availability of the agro-input owing to the subsidy, thus the adequate application of the dosage which increase the rice output in the studied area. Therefore, the marginal and elasticity implications of a unit increase in NPK fertilizer by 1 kg will lead to an increase in the rice output by 6.03kg and 0.289% respectively. The positive significance of the two forms of human labour used *viz.* family and hired labours is an indication of absolute absorption which owed to labour intensiveness required in performing various and tedious farm operations in the rice farms with little or no case of excess for the cheaply and almost free labour sourced from farm family, and judiciously use of the hired labour owing to money cost. Thus, the marginal and elasticity implications of a unit increase in family and hired labours by 1 manday will lead to an increase in the rice output by 7.47kg and 0.106% for the former; and 6.62kg and 0.063% for the latter, respectively.

On the other hand, for the non-significant variables captured in the model, their sizes and signs to some extent have empirical implications. The positive non-significance of the estimated parameter for seed did not owe to the use of local variety as almost all of the farmers used improved seed variety but rather owes to improper and low adoption of the recommended quantity due to poor technical know-how for the former and insufficient quantity owing to high cost associated with improved variety for the latter, thus exerting insignificant influence on rice output. Also, the positive non-significance of the urea and herbicides is associated with low usage below the recommended dosage owing to the high cost associated with these agro-inputs, thus not exerting significant influence on the rice output. The negative non-significance of the estimated parameter for depreciation on capital items did not come as a surprise as the farmers been smallholders used crude/primitive tools to perform virtually all the operations in their farms and these implements been replaced every cropping season due to wear and tear, the extra cost been incurred affects the output of rice in the studied area.

Furthermore, since the farmers were operating in the long-run, it was observed that the farmers were operating within the economic or rational production region as indicated by the sum of the return to scale value of 0.978 i.e. stage II which is noted to be decreasing return to scale given that the input in relation to the output at ascending level change in descending proportionate order. In other words, it implies that any extra unit of input will lead to an increasing-decreasing increase in the output level *ceteris paribus*, i.e. the proportionate increase in the succeeding output level will be less than that of the preceding output level. The implication is that the farmers can increase their output by efficiently utilizing the available programme recommended technologies at their disposal.

A perusal of Table 3 showed the farm size to account for the highest contribution to the output then followed by herbicides even though it was non-significant and then human labour and NPK fertilizer which are almost at par as evident by their respective marginal physical product (MPP) values. However, the seed and urea fertilizer made the least contribution to the output as indicated by their respective MPP values. The MPP value for the depreciation on capital items showed that instead of a positive contribution it made a negative contribution to the output of rice owing to use of crude implements to perform most of the operations in the farms. The technology used and the managerial efficiency increases the output of rice by 106.27kg which under normal circumstances should be more than this value if the farmers complied with the recommended practices extended to them by the programme. Thus, based on the above MPP results, it can be concluded that the farmers were more technically efficient in the use of land

Since the results showed that the farmers were operating in the economic production region in which optimum production point exist, therefore, the farmers at the existing available technology need to allocate their resources efficiently keeping in view the prevailing market prices in order to

Table 3: Technical and Allocative efficiencies of rice farmers

Inputs	Mean	APP	MPP	EP	MPV	MFC	AEI	D(%)	Decision
Farm size	1.33	3622.857	1475.41	0.40725	221311.5	5000	44.2623	97.74074	**UU**
Seeds	51.93	92.78644	3.985	0.042948	597.75	355	1.683803	40.61062	**UU**
NPK	230.91	20.867	6.0323	0.289083	904.845	160	5.655281	82.31741	**UU**
Urea	127.27	37.85967	2.0503	0.054155	307.545	160	1.922156	47.97509	**UU**
Herbicides	4.96	971.4516	28.1299	0.028957	4219.485	1500	2.81299	64.45064	**UU**
Family labour	68.44	70.40327	7.467	0.10606	1120.05	800	1.400063	28.57462	**UU**
Paid labour	46.14	104.43	6.6226	0.063417	993.39	800	1.241738	19.46768	**UU**
Depreciation	4170.6	1.155325	-0.0161	-0.01394	-2.415	1.18	-2.04661	148.8613	**OV**

Source: *Field survey, 2018*
Note: *UU = Under-utilization; OU = Over-utilization*
RTS = 0.98; Output $\overline{Y}$ *= 4818.40;* P_y*/kg = ₦150*

Table 4: MRTS of inputs used

Inputs	Seeds ↓	NPK ↓	Urea ↓	Herbicides ↓	Family lab ↓	Paid labour ↓	Dep. ↓	Farms ↓
Seeds ↑	1	0.66061	1.943618	0.141664	0.533682	0.601727	247.516	0.002701
NPK ↑	1.513752	1	2.942155	0.214444	0.807861	0.910866	374.677	0.004089
Urea ↑	0.514504	0.339887	1	0.072887	0.274581	0.309591	127.348	0.00139
Herbicides ↑	7.058946	4.663213	13.71989	1	3.767229	4.247561	1747.2	0.019066
Family labour ↑	1.873777	1.237836	3.641906	0.265447	1	1.127503	463.789	0.005061
Paid labour ↑	1.661882	1.097857	3.230064	0.235429	0.886916	1	411.342	0.004489
Depreciation ↑	0.00404	0.00267	0.00785	0.00057	0.00216	-0.00243	1	1.1E-05
Farm size ↑	370.2409	244.585	719.6069	52.44988	197.5907	222.7841	91640.4	1

Note: ↓, ↑ means increase and decrease respectively.

maximize profit in rice production which in turn has a significant influence in sustaining the going concern of the business.

The empirical evidence showed that virtually all the resources used with the exception of depreciation on capital items were under-utilized due to poor adoption of the recommended technologies at their disposal with farm size having the highest index value of 44.26 followed by NPK fertilizer (5.66) while the remaining inputs were within the index range of less than 3 and greater than 0 (Table 3). Therefore, the output of rice is likely to increase and hence more gross income if more of these inputs were utilized and less of depreciation on capital items. Furthermore, approximately 97.74%, 82.31%, 64.45%, 47.98%, 40.61%, 28.58% and 19.47% upward adjustments (increase) for farm size, NPK fertilizer, herbicides, urea fertilizer, seeds, free labour and paid labours respectively, are required for the attainment of optimum allocation in rice production. In addition, approximately 148.86% downward adjustment (reduction) of depreciation on capital items is required for optimum allocation.

The marginal rate of technical substitution (MRTS) was estimated to show how the scale of production responds to two inputs substitution (Table 4). It was observed that the MRTS of farm size for seeds was 370.24, implying that 1 hectare of operational size for rice can be substituted for 370.24kg of seeds without changing the output scale. Also, the MRTS of herbicides for seeds was 7.08, meaning that 1litre of herbicides can be substituted for 7.08kg of seeds while still maintaining the same output level. The MRTS of NPK and urea fertilizers for seeds were 1.51 and 0.52 respectively, indicating that 1kg each of the NPK and urea fertilizers can be substituted for 1.51kg and 0.52kg of seeds respectively, without affecting the output scale of rice. The MRTS of free and paid labours for seeds were 1.87 and 1.66 respectively, indicating that 1 manday each for free and paid labours can be substituted for 1.87kg and 1.66kg of seeds respectively, without affecting the scale of the output.

CONCLUSION AND RECOMMENDATIONS

Based on the empirical findings it can be inferred that the farmers were within the economic region in which economic optimum point can be attained but were not efficient in the utilization of their productive resources owing to poor adoption of the available recommended production technologies at their disposal. In addition, the market imperfections *viz.* input and output prices affected their efficiency in optimizing the allocation of the productive resources they employed in rice production in the studied area. Therefore, the study recommends the need to strengthen technical skill capacity build-up of the farmers *viz.* adequate extension advisory services delivery. However, farmer to farmer extension approach is strongly suggested for cost-cut, reduction in the bureaucratic bottleneck and unnecessary time waste associated with the conventional extension service delivery in the studied area. In addition, consumption credit should be provided to the farmers in order to make the advanced production credit viable and productive, thereby making the farmers utilize the production credit for what it's meant for rather than being diverted for capital consumption items. Also, the economic status of the farmers i.e. been resource poor, the need for the provision of subsidy on agro-chemical is very important due to market imperfection as they are operating in an environment beclouded with risks and uncertainties.

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Agrarian Change in Telangana: A Discussion on Policy Options

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ABSTRACT

The paper examined the inclusiveness of strategies for increasing farmers' incomes in Telangana from the last two decades by using various government reports and statistical abstracts of the Telangana state. Telangana agricultural sector is in a transition from cereal based cropping systems to commercial crops based cropping systems with larger contribution from fruits and vegetables and commercial crops like cotton and soybean. The commercialization of agriculture resulted in high input-high output-high risk agriculture, where in small and marginal farmers are not able to cope with and ultimately end up in huge debt with higher cost of production. Further, faster farm mechanization in the recent years, resulted in increased scale economies with small farmers getting less profit compared to large farmers per unit area. The tenant farmers are especially at risk in the event of yield loss or output price reduction, as they have to pay tenancy fee of about 30% of the average farm returns, even though their yields are lower than average. Remedy is livestock sector, now its contribution is equal to crop sector to gross state domestic product. If an average agricultural household to cross poverty line, he has to have 4.41 hectare of land in Telanagana.

Highlights

- Farm mechanization increased across farm size groups.
- Large farms are more profitable than small farmers per unit area.
- Farmer's producer companies/cooperatives need to be encouraged.
- Crop insurance needs to be encouraged.

Keywords: Agrarian change, agrarian policies, farmer's income, India

The Telangana state is a newly formed state and majority of the rural population depends on agriculture in the state. Telangana economy is largely dependent on big conglomerate city Hyderabad which is a hub for not only information technology, but also real estate, construction, manufacturing and pharmaceutical companies, although majority of the population dependent on agriculture and allied activities for their employment, income and livelihoods. There was growing disparity of people living in urban centres and rural areas which was reflected in increased farm distress and large number of farmers suicides by farmers (Reddy and Bantilan, 2013; Reddy *et al.* 2014). About 86% of the farmers are small and marginal with very limited asset base, their costs are increased but the increase in returns are much below the increase in costs, resulted in reduction in the net returns, increase in indebtedness and farm distress (Chand and Srivastava, 2016; Joshi *et al.* 2004). The cost structure ofcrops is in a transition stage from the subsistence to commercial agricultural with rapid mechanisation, more dependent on casual labourer and hired services in most of the agricultural operations staring from land preparation to harvest (Radhakrishna Report on Andhra Pradesh; Reddy and Singh, 2015). Although paddy is a major crop, diversification towards cotton and horticultural

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crops (now horticulture contributes to 40% of the total agricultural value of production) and livestock is playing a significant role in agricultural growth of the state. The recent structural changes with high demand push to high value crops like horticultural crops, meat, milk and other animal products is the driving force behind the rapid changes in Telangana agriculture. Growing regional disparities within states with more farmer distress in backward districts were observed by many studies (Reddy, 2011; Reddy and Kumar, 2006; Reddy, 2015). Keeping this, the paper examined changes in the farmers situation not only in crop sector but also in horticulture and livestock sector to understand the impact of changes in the agrarian economy on farmers' incomes and livelihoods in Telangana. The specific objectives of the paper are:

1. To understand the macro-level changes in agrarian economy of Telangana state;
2. To analyse the growth in crop and livestock sector and also changes in input composition at district level over the past decade;
3. To map out the strategies for achieving inclusive and sustainable agriculture growth in Andhra Pradesh.

MATERIALS AND METHODS

The data was collected from various government statistical publications. Mainly season and crop reports of Directorate of Economics and Statistics, and Statistical Abstract of Government of Andhra Pradesh and Situation Assessment Survey of National Sample Survey Organisation have been used (NSSO, 2013). The data for the study mainly covers from 1990 to 2015-16 depending on the availability on the various parameters. This study covers changes in land use pattern, farmer's situation in terms of sources of incomes, crop returns and indebtedness. All the ten districts were considered while analysing major indicators of development and agrarian change including land use pattern, area, production and yield and gross value of output. The data pertaining to the districts of Rangareddy and Hyderabad were pooled and presented under Ranga Reddy district for some variable wherever the data was a time series spanning from 1970s.

RESULTS AND DISCUSSION

Telangana state is predominantly rural with 61.12% of the population lives in rural areas and mostly depends on agriculture. In the state, share of agricultural sector in State Gross Domestic Product (SGDP) was 13%, while share of services was 61% and the remaining 22.5% was contributed by industry. The crop sector and livestock contribution is equal at 5.9% of SGDP each. Within crop sector horticulture contributes to 40%. Small and marginal farmers share was 86% in total cultivators, their incomes are meagre from crop sector, hence there was a proletarianization of small farmers in the last decade in addition to feminization of agriculture.

Telangana macro-economic trends

The gross state domestic product increased significantly over the last ten years from 2004-05 to 2015-16 from 90 thousand crores to 237 crores in constant prices. The share of agriculture in Gross State Domestic Product (GSDP) of Telangana was reduced to 13% in 2015-16 (Table 1). Year-to-year growth in GSDP is erratic. The declining share of agriculture is a good sign, if the growth in employment intensive secondary sector absorbs surplus labour. But the growth in employment in the rural non-farm sector is subdued to absorb the labour released from agricultural sector.

The declining share of agriculture is also accompanied by a structural shift within agricultural sector. Share of crop sector was decreased from 9.6% of GSDP in 2011-12 to 5.9% of GSDP in 2015-16 mainly driven by the declining area under food

Table 1: Share of agriculture in GSDP of Telangana

Sector	2004-5	2005-6	2006-7	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Share of agril.	18	19	17	15	16	17	17	15	13
GSDP (₹ 1000 Crore)	90	104	116	174	189	197	206	217	237
Year-on-year growth		15.9	11.6	18	8.7	4.1	4.8	5.3	9.2

Source: *Socio-Economic Outlook, 2015; GSDP is at constant prices of 2004-05.*

Table 2: Contribution of sub-sectors to agricultural GSDP

	% share in GSDP					Growth (%)			
Sector	**2012**	**2013**	**2014**	**2015**	**2016**	**2013**	**2014**	**2015**	**2016**
Crops	9.6	10.3	9.8	7.8	5.9	8.0	1.7	-14.2	-18.2
Livestock	5.6	5.9	5.7	5.7	5.9	8.0	2.3	8.2	12.2
Forestry	0.6	0.6	0.5	0.5	0.4	-0.6	-2.5	1.4	-2.7
Fishing	0.4	0.5	0.5	0.5	0.6	10.4	14.4	8.5	17.8
Agril. and allied	16.1	17.2	16.5	14.5	12.9	8.8	2.1	-5.3	-4.5
Secondary	27.3	23.5	23.2	22.4	22.5	-12.2	4.8	3.8	8.6
Tertiary	52.5	55.2	56.6	58.9	60.5	7.7	8.9	11.8	11.0
All	100	100	100	100	100	2.3	6.2	7.5	8.1

Source: *Socio-Economic Outlook, 2015-16, Telangana.*

crops with simultaneous increase in area under horticultural and commercial crops like cotton. Now horticulture contributes to about 40% of the crop sector (Table 2). In year 2015-16 livestock sector contribution is equal to that of crop sector (5.9% of the GSDP) mostly driven by the increase in demand for goat and sheep meat, poultry and milk products. During the drought year's (2014-15 and 2015-16) crop sectors contribution is drastically reduced, but livestock and fisheries sector contribution is stable or increased. Given that the Telangana agriculture is mostly dependent on monsoons, it is advisable to encourage livestock farming by the farmers not only to adopt and mitigate the impact of the bad monsoons but also to create employment among small and marginal farmers and also agricultural labourer. Performance of tertiary sector is much better and stable with year-on-year growth never below seven percent from 2012-13. Now the tertiary sector contributing to about 60.5% of GSDP, but it is not a major employment provider for the persons who are withdrawing from agricultural sector as it is more skill intensive with less number of jobs. The secondary sector growth is subdued, but better than the agricultural sector and now it contributing to about 22.5 % of the GSDP. Within secondary sector construction sector contributed higher share followed by manufacturing.

Cropping pattern change

In the past decade there was an increase in share of area under non-food crops in total cropped area across all districts. The area under non-food crops increased from 26% in 2003-04 to 42% in 2014-15 (Fig. 1). It is mainly driven by the expansion of area under cotton due to the introduction of Bt cotton varieties and red chillies in some districts. The cotton area increased even in dry lands, farmers attracted for the huge returns due to cotton cultivation and expanded cotton area under irrigation by digging new bore wells to reap higher productivity. However, expanding area under Bt cotton and chillies also increased risk infarming to most of the small and marginal farmers. Cotton and chillies are high cost-high return-high risk crops, which brings in disaster for small and marginal farmers who did not have risk bearing ability.

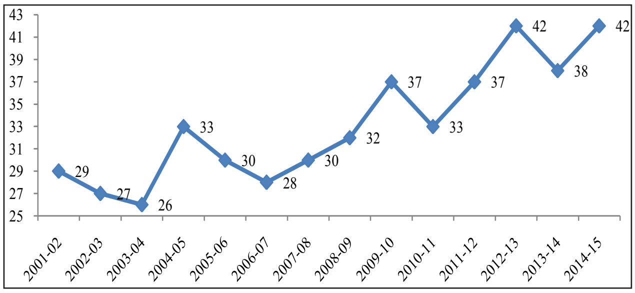

Fig. 1: Share of non-food crops in cropped area

Most of the irrigated-dry lands were converted to non-food crops (cotton, red chillies) during the past decade, mostly in districts like Adilabad, Nalgonda, Warangal and Mahabubnagar. However, farmers prefer to grow paddy wherever secured water source is available from ponds and canals.

Cotton (33% of cropped area), paddy (28%) and maize(14%) are major crops in Telangana. Pulses occupy about 8.4% of the gross cropped area, predominant pulse crop is redgram with 4.4% of GCA. Food grains (cereals plus pulses) occupy about 52.4% of GCA. Oilseeds occupy 9.6% of GCA, mainly contributed by newly introduced soybean(5.4%) and traditional groundnut (2.4%). Cotton is a major single crop occupying largest area in Telangana with 32.7% of GCA. Among spices, red chillies are prominent which occupy about 1.5% of GCA.

Table 3: Composition of horticultural crops in area and production (2015-16)

Horticultural crops	Area	Production
Fruits	54%	55%
Vegetables	22%	36%
Plantation crops	4%	1%
Spices	19%	8%
Flowers	1%	0.2%
Total	7.01 lakh ha	74.79 miliontonnes

Source: *Crop and Seasons Reports, Government of Telangana.*

Although share of horticulture area in gross cropped area was only 14%, it contributed to 40% of the crop value added in Telangana in 2015-16. As per the 1st Advanced Estimates, horticulture crops are grown in an area of 7.01 lakh hectares in 2015-16 producing about 74.79 MTs output (table 3). Of the total horticulture cultivated area, fruits constitute around 54.5%, followed by vegetables and spices with 22.2% and 19.1% respectively. Floriculture constitute about 0.4% of area under horticulture. Out of the total production of horticulture in 2015-16, fruits constitute around 55% followed by vegetables, spices and flowers with 36%, 8% and 0.2% respectively. Out of the total horticulture area, highest area is covered by mango 29%, followed by mosambi 19%. Among vegetable crops, tomato and onion cover around 33% and 15% of the area respectively and 39 % and 16%of production under vegetable. Among spices, the turmeric and red chilli cover around 41% and 31% of the area and 55% and 20% of production respectively. Among flowers, marigold covers around 50% of the area and 65% of production.

Livestock

Livestock contributes to 5.9% of GSDP and its contribution is increasing year after year. Now contribution of livestock to GSDP is almost equal that of the crop sector(including agriculture and horticulture) in terms of value addition Except cattle population, population of all other species increased from 1987 to 2012 (Table 4). There was a much higher growth in buffaloe compared to cattle population especially among female buffalo. When compared to even female buffaloe, growth rate in sheep, goat and poultry are much higher. This is mainly due to increased demand for consumption of meat and milk as consumers income increased over the years.

Table 4: Livestock population since 1987 to 2012

Species	1987	2012	% change over 1987
Cattle	6.7	5.0	-25.0
Adult female cattle	1.8	2.0	10.4
Buffaloes	2.9	4.2	45.5
Adult female buffalo	1.4	2.8	102.2
Sheep	3.0	12.9	331.9
Goat	2.0	4.7	131.7
Total livestock	14.9	27.0	81.7
Poultry	16.7	69.2	313.6

Source: *Livestock census, Government of India.*

Production of milk increased from 1.9 million tonnes in 2002 to 4.4 million tonnes by 2016, eggs also doubled from 6.1 billions to 11.2 billions, meat increased from 1.9 lakh tonnes to 5.4 lakh tonnes and wool increased from 3.0 million kg to 4.6 million kg during the same period. Now Telangana has become hub for poultry activities in south India. Given the high potential of increasing demand for livestock products in the coming decades, there was a good potential to expand livestock production with semi-intensive production systems in the areas adjacent to urban centres and even in faraway rural areas with sufficient market and road infrastructure.

Increased agricultural labourer and tenant farmers

Until 2001, the decadal growth rate of cultivators increased. But between 2001 and 2011 the growth rate was negative, and absolute number of cultivators declined from 33 lakh in 2001 to 30 lakh in 2011, while agricultural labourer increased significantly from 32 lakh to 46 lakh a largest increase in agricultural labourer (Table 5). Most of the agricultural labourer are engaged in tenant farming by leasing-in land from absentee land lards.

Development concentrated around Hyderabad

The percapita DDP was much higher in urban centres like Hyderabad (₹ 2,94,220/-) and Rangareddy (₹ 1,80,039/-) compared to state average of ₹ 1,29,182

Table 5: Population dependent on agriculture

Year	Total population (in lakhs)	Growth Rate	Rural Population(lakh)	Cultivators (lakh)	Agricultural labourer	Total (cultivators and agricultural labourer)
1951	108		85 (79%)	38	16	55
1961	127	18	103(81%)	29	17	46
1971	158	24	125(79%)	24	22	46
1981	202	28	151(75%)	31	28	59
1991	261	29	182(70%)	34	40	74
2001	310	19	211(68%)	33	32	65
2011	350	14	214(61%)	30	46	76

Source: *Socio-Economic Situation Outlook, 2016.*

Table 6: District level indicators

District	Average growth rate of GDDP from 2005-06 to 2013-14	Percapita income in 2014-15	Urbanization (%) in 2011	% increase in urban population between 2001 and 2011	% change in rural population between 2001 and 2011	Share of agriculture in DDP		
						Crop	Livestock	Agriculture
Adilabad	5.9	76,921	28	16	8.7	20	4	24
Hyderabad	10.0	2,94,220	83*	38*	-3.7*			
Karimnagar	9.3	90,184	25	40	1.0	17	6	23
Khammam	8.0	1,02,919	23	29	4.1	15	6	21
Mahbubnagar	10.1	80,121	15	64	9.9	16	11	26
Medak	12.0	1,21,639	24	89	1.2	12	7	19
Nalgonda	10.4	1,14,353	19	54	0.6	14	8	22
Nizamabad	9.4	78,828	23	39	2.2	13	4	17
Rangareddy	12.3	1,80,039				4	10	14
Warangal	8.0	81,221	28	60	-3.5	22	5	27
State (total)		1,29,182	39	41	2.4			

Source: *Statistical Abstracts, Telangana *Hyderabad included Rangareddy.*

in year 2014-15 (Table 6). The lowest percapita income was in Adilabad (₹ 76,921/-), Nizamabad (₹ 78,828/), Mahbubnagar (₹ 80,121/-), Warangal (₹ 81,221/-) and Karimnagar (₹ 90,184/-). During the last decade growth rate in GDDP was highest in districts around Hyderabad like Rangareddy, Madak, Nalgonda, with growth rates were less in faraway districts from Hyderabad like Adilabad, Khammam and Warangal. It shows that there was a some backwash effect with the development of Hyderabad, which is absorbing skilled manpower and capital from distant districts which is also visible from the migration from the distant rural centres to urban centres mainly to Hyderabad. DDP growth rates were also lower in the districts with larger share of agriculture and less urbanization like Mahabubnagar in spite of nearness to Hyderabad.

Between 2001 and 2011, rural population increased by just 2.4%, where as urban population increased by 41%. This trend is similar in all districts, with Warangal recorded a negative growth which indicating the attractiveness of urban migration and distress situations in rural areas across all districts.

Historically, in Telangana agriculture played a significant role, however its share in GSDP is gradually reduced to just 12-13% in the recent years. Now service sector contributing to up to 61% of GSDP. Within agricultural sector share of livestock was increased and now contributes to about 44% of agricultural and allied sectors.

Proletarianization and Feminization of agricultural labour

Table 7 presents district wise composition of cultivators and agricultural labourers. As per the population census 2011, there were 91.7 lakh main

Table 7: Number of cultivators and agricultural labourer in lakhs (2011)

	Cultivators			Agricultural labour			Ratio of labour to cultivator
District	**Persons**	**Male**	**Female**	**Persons**	**Male**	**Female**	
Adilabad	3.6	2.3	1.3	4.9	2.1	2.7	1.4
Karimnagar	3.6	2.3	1.3	7.6	3.4	4.2	2.1
Khammam	2.3	1.5	0.7	8.1	3.6	4.4	3.5
Mahabubnagar	5.7	3.6	2.1	9.3	3.7	5.6	1.6
Medak	3.5	2.2	1.3	5.7	2.5	3.2	1.6
Nalgonda	3.3	2.2	1.1	8.6	3.5	5.2	2.6
Nizamabad	2.8	1.8	1.0	4.5	2.3	2.2	1.6
Rangareddy	3.0	1.9	1.1	3.7	1.6	2.1	1.2
Warangal	4.0	2.6	1.5	7.6	2.9	4.6	1.9
State (total)	31.8	20.3	11.5	59.9	25.7	34.2	1.9

Source: *Population census, Government of India, 2011.*

Table 8: Share of number of small and marginal farmers (% to total farmers)

	1971			2011			
District	**Marginal**	**Small**	**S & M farmers**	**Marginal**	**Small**	**S & M farmers**	**Average land holding size (ha)**
Adilabad	31	17	48	50	28	78	1.40
Karimnagar	54	17	71	67	22	89	0.96
Khammam	34	21	55	62	23	85	1.14
Mahaboobnagar	21	17	38	58	25	83	1.23
Medak	41	22	63	68	22	90	0.97
Nalgonda	31	19	50	59	25	84	1.19
Nizamabad	52	20	72	67	24	91	0.92
Rangareddy	26	20	46	58	26	84	1.22
Warangal	47	20	67	67	21	88	1.01
State (average)	39	19	58	62	24	86	1.12

Source: *Population Census, Government of India.*

workers dependent on agriculture in the state, out of which 45.9 workers are male and another 45.7 were female workers (Table 7). There were 31.8 lakh cultivators and 59.9 lakh agricultural labourer. Number of male cultivators (20.3 lakh) was higher than female cultivators (11.5 lakh). But number of agricultural labourer were higher among females (34.2 lakh) compared to men (only 25.7 lakh).

There was reduction in cultivators (9% reduction), but increase in agricultural labourer (27% increase) between 2001 and 2011, indicating proletarianization of cultivators in Telangana. Overall, there was increase in persons dependent on agriculture between 2001 and 2011, but there was significant structural change towards feminization and casualization of agricultural sector. Persons dependent on agriculture increased by 12%, the increase was higher among women (13%) then among men (only 10%). The above figures indicate that there was a clear trend of proleterianization of cultivators during the past decade and also feminization of agricultural labourer.

Increased number of small and marginal farmers

Since 1970s, the share of small and marginal farmers was increased in the total cultivators (Table 8). Now, in Telangana 86% of the farmers are small and marginal based on 2011 census data. Share of marginal farmers was increased from 39% from 1970 to 62% in 2011. And the average land holding is just 1.12 hectares. This also explains the above argument of shifting from cultivation to agricultural labourer.

Changing relationship between Farm size and profitability

Given that 86% of the farmers are small and marginal farmers, it is important to see the profitability of small farmers in the recent years. We have presented the cost of cultivation and returns in

Table 9: Farm size and profitability relationship (20013-14) for Telangana state (per hectare)

Crop	Farm size group	Yield (qtl)	Cost C2 (₹)	Gross Return (₹)	Net return (₹)	Fertilizer (kg)	Labour (days)	Animal labour (days)	Machine labour (hours)
Cotton	Small	16	68271	66948	-1323	220	1832	7	21
	Medium	15	65544	64444	-1100	225	2045	6	18
	Large	17	65321	70655	5334	229	2040	6	21
	All	16	66280	68111	1831	225	1977	6	20
Maize	Small	57	65184	72228	7044	233	1455	6	16
	Medium	54	59170	69896	10725	219	1361	4	13
	Large	56	58671	71473	12802	208	1298	5	16
	All	55	60441	71215	10774	217	1355	5	15
Paddy	Small	54	67744	76528	8785	237	1227	2	16
	Medium	55	65047	77767	12720	238	1050	2	14
	Large	56	62170	78083	15913	225	1128	1	17
	All	55	64614	77509	12895	232	1143	2	16

Source: *Calculated from Cost of Cultivation Scheme unit data.*

Table 10: Percentage distribution of persons who were self-employed in agriculture during July-Dec 2012 by principal status during Jan-Jun 2013 for Andhra Pradesh and Telangana

State	Self-employed		Regular wage/ salaried employment		Casual wage labour in public works	Casual labour in		Unemployed	Out of labour force	All
	Agriculture	non-agriculture	agriculture	non-agriculture		agriculture	non- agriculture			
AP	83.3	0.2	0.2	0.4	0.4	13.3	0.4	0	2	100
Telangana	91.4	2.8	0	0.2	1.9	1.2	1.6	0	1.4	100
All India	84.9	1	0	0.5	0.8	4.2	3.1	0.3	5.2	100

Source: *NSS 70th Round. Situation Assessment Survey of Agricultural Households, All India Debt and Investment & Land and Livestock Holdings in India (January'2013 - December'2013).*

table 9 for the year 2013-14. The results show that there was a tendency of increasing profitability with the increase in farm size among all crops in Telangana. This is mainly due to rapid adoption of cheaper farm machinery in the large farms to replace the human and bullock labour which is becoming costly and scarce in the recent years. Although there was no systematic relationship between farm size and productivity, there was a significant inverse relationship between farm size and cost of cultivation, resulted in increased profitability on large farms. This is a disturbing trend and reason for increased distress among small and marginal farmers. From the above analysis it is clear that small and marginal farmer's income are too minuscule from their crops, so they have to depend on non-farm sources of income to sustain their livelihoods. Especially it is very hard for tenant farmers who have to give at least 30% of the produce to landowner.

Income from other sources

An examination of the employment status of persons of agricultural households shows that other sources of employment and income are meager in Telangana compared to Andhra Pradesh and All-India (Table 10). Self-employed in non-agriculture (2.8%), casual labourer in public works (1.9%), casual labourer in non-agriculture (1.6%) and agriculture (1.2%) are some of the few activities in which persons of self-employed in agriculture engaged during the off-season.

In Telangana, agricultural households engaged in multiple occupations, with majority in cultivation followed by livestock, wage/salaried employment (table 11). However, they are not getting significant income from these multiple sources as they may be engaged in these activities only for a few days or on temporary basis.

Agricultural households get ₹ 6311 from all sources, of which major income share is from crop

Table 11: Per 1000 distribution of persons among agricultural household by major source of income during last 365 days for Andhra Pradesh and Telangana state (2012-13)

	Cultivation	Livestock	Other agricultural activity	Non-agricultural enterprises	Wage/ salaried employment	Others
AP	592	46	16	35	280	31
Telangana	868	18	5	18	62	29
India	635	37	11	47	220	51

Source: *NSS 70th Round. Situation Assessment Survey of Agricultural Households, All India Debt and Investment & Land and Livestock Holdings in India (January'2013 - December'2013).*

Table 12: Average annual income and consumption expenditure (₹) per agricultural household byfarm size 2012-13

Size class of Land possessed (Ha.)	Income from wages	Net receipt from cultivation	Net receipt from farming of animals	Net receipt from non-farm business	Total income	Total consumption expenditure	Net investment in productive asset
< 0.01	18084	7692	16680	6588	49044	79752	-1512
0.01 - 0.40	7416	11580	26232	336	45564	51888	4116
0.410-01.00	22932	37764	2004	2208	64908	56256	8616
1.01-2.00	14184	52680	5568	3048	75480	59004	2640
2.01-4.00	13344	71640	-204	6420	91200	68352	7764
4.01-10.00	22332	137688	-3912	372	156480	81372	9120
10.00+	8832	63684	12228	18372	103116	102084	16836
All size	17400	50724	4488	3120	75732	60732	6552

Source: *NSS 70th Round. Situation Assessment Survey of Agricultural Households, All India Debt and Investment & Land and Livestock Holdings in India (January'2013 - December'2013).*

cultivation (₹ 4227), followed by wages (₹ 1450), rearing animals (₹ 374) and non-farm business (₹ 260) (table 12). However, income from labour and animal rearing was much higher among marginal farmers, while income from cultivation increased with farm size. Non-farm business income was higher among large farmers. However, even large farmers with more than 10 hectare area were getting average income of just ₹ 13,040.

Crossing Poverty Mark

To cross the international poverty line of $1.9 per capita per day, a five-member farm household should get an annual net income of ₹ 2, 25,000, whereas Telangana farmers are getting only ₹ 75,732 as annual income and they spend only ₹ 60, 732 as consumption expenditure. Given that average farmer is getting ₹ 25008 from other sources, his family has to get ₹ 1,99,992 from agriculture, but he is getting only ₹ 50,724 from his average holding of 1.12 ha. If he has to get ₹ 1,99,992 from agriculture, his farm size should be increased to 4.41 ha. It indicates that not only small farmers, even majority of the medium farmers will be below the poverty line, if they don't lease-in land with the existing productivity levels.

Trends in Input use (labour, irrigation and credit)

In this section we have examined the labour, irrigation and credit markets. Labour is one of the very important input in agriculture contributing to 20 to 30% of total cost of cultivation. Labour has become scarce in rural Telangana, multiple factors like growing migration to urban centres, MGNREGA, increasing opportunities in construction works as contract labourers within and outside villages, resulted in significant increase in wage rates and scarcity of labour since 2006. To some extent it was leading to the farm mechanization, increased use of tractors and other farm machinery even by small farmers for timely completion of farm operations and also to reduce costs (Fig. 2).

In Telangana, ground water is a major source of irrigation contributing to about 82% of net irrigated area. Number of pump sets is an indication of private investment in agriculture. Number of pump sets increased from 122 thousand in 1972 to 659

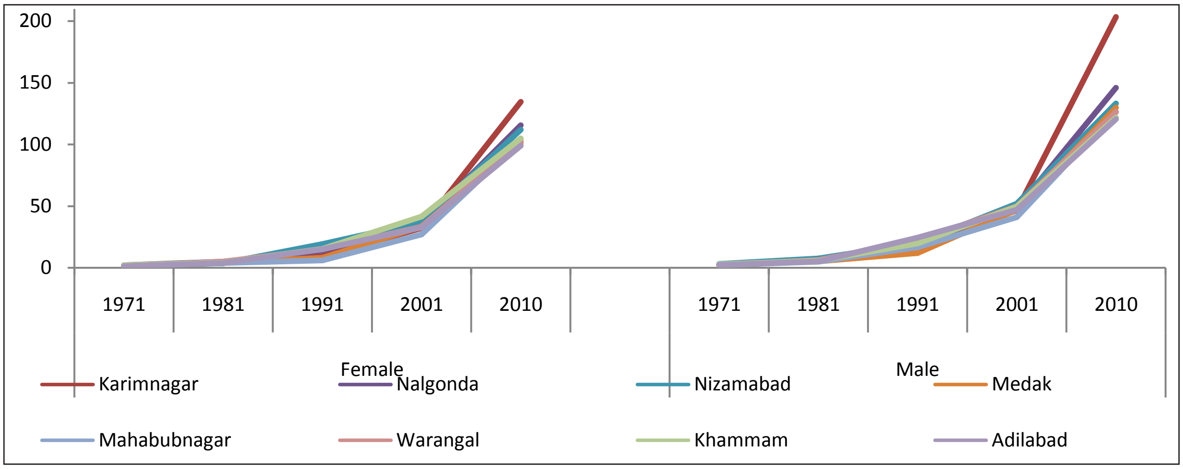

Fig. 2: Wage rates of agricultural workers

thousand by 1992 and further increased to 1062 thousand by 2003 and to 1750 thousand by 2011 (Table 13). The number of pump sets were higher in Karimnagar, Warangal and Nalgonda. But in the recent years growth was higher in Adilabad, Nizamabad and Khammam. After the introduction of Bt cotton in 2002, farmers in backward district like Adilabad also digging bore wells to reap benefits from the Bt cotton cultivation. Alarming increase in pump sets in districts with deep water table is posing a challenge for sustainable water use in Telangana.

Table 13: Number of pump sets (1000)

Year	1972	1992	2003	2011	% change over 2003
Adilabad	3	18	34	100	194
Khammam	4	30	46	102	122
Nizamabad	8	42	78	215	176
Rangareddy	11	23	90	111	23
Medak	12	67	118	200	69
Nalgonda	18	103	140	256	83
Warangal	16	145	153	265	73
Karimnagar	35	149	172	311	81
Mahabubnagar	14	82	232	200	-14
Telangana	122	659	1062	1760	66

Source: *Statistical Abstracts, Telangana State.*

Credit and indebtedness

70th Round of the National Sample Survey (NSS) on "All India Debt and Investment Survey" (data collected during January 2013 to December 2013) gives a picture of the credit structure, asset holding, liabilities, capital formation of the households etc. The average value of the asset for cultivator and non-cultivator in the rural Telangana household is ₹ 13.9 lakh and ₹ 3.8 lakh respectively while at all -India level it is ₹ 28.7 lakh and ₹ 6.7 lakh respectively. The average asset value for rural household of Telangana is ₹ 6.38 lakh and that of urban Telangana is ₹ 18.45 lakh, which is 2.9 times higher indicating high inequality between rural and urban population in the State. The Incidence of Indebtedness (IOI) among the households in rural areas of Telangana is twice higher than the IOI of rural All-India. Around 59% of rural household are indebted in Telangana state as against 31% in All-India. Indebtedness is higher among the cultivators as compared to other occupational category; about 74% of cultivators in Telangana are indebted. While the debt asset ratio among the rural and urban areas of Telangana is around 7.95 % and 8.58% respectively, in case of India it is as low as 3.23% and 3.7 % respectively (table 14).

Indebtedness is one of the major problems that farmers face in the State. As per the "All India Debt and Investment Survey" by National Sample Survey (NSS), 74 percent of the total cultivators in the State are indebtedness. The Government of Telangana has announced a one-time crop loan waiver to end the perpetual indebtedness of farmers through the Crop Loan Waiver Scheme. Under the scheme, short term crops loans (including crop loans against gold) taken by farmers from scheduled commercial banks, cooperative credit institutions and regional rural banks and outstanding as on 31.03.2014 are eligible for waiver. The eligible amount for debt waiver is up to ₹ 1 lakh, including loan amount and interest

Table 14: Incidence of value of assets, indebtedness and debt in Telangana and India

Rural	Average value of assets (₹ lakh)	Incidence of indebtedness (in %)	Amount of debt (₹)	Debt-Asset Ratio
Telangana				
Cultivators	13.89	74	84423	6.1
Non-cultivators	3.80	54	39142	10.3
All-India				
Cultivators	28.73	46	70580	2.5
Non-cultivators	6.75	29	25741	3.8

Source: *NSS 70th Round. Situation Assessment Survey of Agricultural Households, All India Debt and Investment & Land and Livestock Holdings in India (January' 2013 - December' 2013)*

up to 31.08.2014. However, the benefits of the scheme are only realized if there were some efforts to reduce cost of cultivation to farmers through input subsidy etc.

Analysis of recent policies

The Ministry of Agriculture and Farmers Welfare recently released the first four volumes of the Report of the Committee on Doubling Farmers' Income (DFI). It answered some key questions such as doubling of real income rather than nominal income, doubling incomes across regions uniformly may not be possible, and the approach should be region-specific with higher growth in less developed States and lower growth in more developed States to reduce regional inequalities (Reddy, 2017 and 2018).

Current farmer's income

An average agricultural household earns income from cultivation, livestock, non-farm business, and wages and salaries. At the national level, this average income is targeted to be doubled in seven years by 2022-23. The aggregate base year's (2015-16) all-India average income of an agricultural household is estimated at ₹ 96,703 at constant (2015-16) prices. The doubling would imply that the average farmer's household income would go up to ₹ 1,93,406 measured at 2015-16 prices. In line with this goal, the government has initiated and strengthened various development programmes such as interest subvention on crop loans, National Food Security Mission, Rashtriya Krishi Vikas Yojana, Accelerated Pulses Production Programme, Soil Health Card Scheme, Pradhan Mantri Krishi Sinchai Yojana, National Agricultural Market for Electronic Trading, National Livestock Mission, and Pradhan Mantri Fasal Bima Yojana (Reddy, 2017, 2017a; 2017b; 2018). All these provide greater flexibility to States to use the funds as per the local requirements, unlike the earlier pan-India uniform programmes. Though these centrally-sponsored programmes are important, Telangana government's programmes including Mission Kakatiya and the proposed financial aid of ₹ 8,000 per acre per year for farmers are also equally important to achieve the goal.

De-risk Diversification

Studies show that diversification to high-value crops such as fruits and vegetables and output prices are main sources of income growth. However, they are also major causes of distress due to high fluctuations in prices. Farmers can gain from diversification only if risk-mitigating strategies are popularised among them. They also need non-exploitative markets for various inputs to facilitate diversification to commercial and horticultural crops. Right seed at the right time at a reasonable cost, availability of fertilizers, micronutrients including bio-fertilizers at cheap rate, custom-hiring centres and farm machinery — all these will lead to increased incomes.

Better management of post-harvest transport, processing, storage, packaging, marketing and price realisation is also required. Minimum support price is now a key policy instrument to support farmers (Darekar and Reddy, 2017). Cotton price forecasting in major producing states. But most of the developed countries and even a few developing ones have already moved to income support policies. India too needs to move to income support policy to meet its national objective of doubling farmers' income by 2022. Without income support policies, this goal cannot be achieved in rainfed and backward districts where the scope for increasing farmers' income is limited.

Tenant and Small Farmers

There is a growing number of tenant farmers, who hardly get any support from the government. About 67% of the farmland is held by small and marginal farmers with holdings below one hectare, while their share in total private agricultural investment is less than 10%.

Even for these small investments, small and tenant farmers depend on informal sources of credit at exorbitant interest rates, which reduces their economic viability. This indicates that there is a need for encouraging private investment among these farmers either through easy credit or through innovative community-PPP mode.

Crossing Poverty Mark

To cross the international poverty line of $1.9 per capita per day, a five-member farm household should get an annual net income of ₹ 2,25,000. Assuming that the farm household gets 40% of income from non-farm sources, still his net returns should be ₹ 1,35,000 from farm sources.

If we consider ₹ 20,000 net income per hectare per season, with two crops per year, the farm household needs to have a minimum of three hectares to cross the poverty line. It indicates that not only small farmers, even majority of the medium farmers will be below the poverty line, if they don't lease-in land with the existing productivity levels.

Non-farm Opportunities

The report states that on average 60% of farmers' income is from the agricultural output (including livestock) and the remaining from non-farm sources. It advises that the ratio of farm to non-farm income should be raised from the existing 60:40 to 70:30 by 2022. This is unrealistic because as the economy develops there would be more opportunities in the non-farm sector rather than in the agricultural sector. Moreover, the assumption of increasing the ratio from 60:40 to 70:30 may not be the right target, given the past experience of Punjab, Haryana, Tamil Nadu and Kerala as with the development of agricultural sector, the ratio of farm to non-farm incomes has decreased significantly rather than increasing. Hence, there should be a strategy to increase non-farm incomes while doubling farmers' income as well.

Public Investment

The DFI report estimated that an additional Rs 6,39,900crore investment is needed for doubling farmers' income. The size of public spending on agriculture and irrigation as a percentage of the GDP should be raised from the existing 2% to 4% as public investment bears a strong relationship with private investment and income. For a targeted 10.41% annual increase in farmers' income, the estimated increase in weighted public investment (together in agriculture, irrigation, rural roads and transport and rural energy) would be 14.17% per year and the private investment has to grow at 8% per year, it said. India can save huge post-harvest losses (₹ 35,000 crore per annum assuming a conservative estimate of 15% loss of the total production) by investing about ₹ 1 lakh crore in cold chains among others. This investment can be recovered within three years. Farmers should be made partners in the cold-chain/agri-logistics to enable them to benefit from access to bigger markets and realisation of remunerative prices. Overall, effective implementation of government programmes, farm diversification towards high-value crops, competitive price, enhanced investments and income support should be the strategies for doubling farmers' income.

Policies adopted by Telangana state government

During the past four years, many innovative schemes have been introduced both by Central and State governments with varied rates of success. It is now time to look back and identify schemes, which have the potential to increase farmers' income, to replicate and scale them up nationwide. It is also important to see not just financial allocation, but also design and innovativeness to ensure the desired impact. Below are the some of the important state government schemes for enhancing farmer's income.

Rejuvenating Tanks

Minor irrigation sources like tanks were developed, maintained and used for both irrigation and drinking water in India. However, due to lack of maintenance most of them vanished. In Telangana itself of the about 80,000 tanks, only some 46,000 exist now. The Telangana government is implementing Mission Kakatiya to rejuvenate these 46,000 minor irrigation tanks since the last four years. Its impact is visible in improved water table, expanding cultivated area, increasing area under multiple crops and area under remunerative crops like paddy. While rejuvenation works pertaining to 15,649 tanks were completed in three phases, rejuvenation of 5,650 tanks is going on in Phase IV. Many socio-economic impact studies show that not only farmers' income increased significantly, but livelihoods of fishermen and washerman improved as well. The scheme received the appreciation of Central government and Niti Aayog for its effective implementation in terms of reducing costs and farm distress, increasing yields, incomes and profits. It also increased water table in surrounding villages, thereby ensuring water availability in borewells. Now 24-hour free electricity is helping farmers to reap the benefits of this increased water table by expanding the irrigated area under borewells.

Sanitising Land Records

The land records updation and 'purification' (rectification) programme was praised by the chief economic adviser as "heart of good governance". The Telangana government conducted an extensive land survey from September 15 to December 15 last year, cleaned land records and uploaded details on the website called Dharani. This facilitates entry of buying and selling of agricultural land in real time, similar to core banking. A total of 71,75,096 farm holdings with a cultivable area of 1,42,12,826 acre was recorded. Based on this land records, fictitious land transactions will be eliminated and the exact land for investment support would be decided.

Farm Investment Subsidy Scheme

Under the Farmers Investment Subsidy Scheme (FISS), money is directly transferred — ₹ 4,000 per acre per season into farmers' hands based on the land records updation programme. The unique feature of the scheme is its universal coverage of each acre of cultivated land. Land records will be seeded with Aadhaar and bank account and geotagged to satellite data to estimate the cropped area of each farmer. It is easy to administer and based on readily verifiable land records data, which is linked to Aadhaar, there is no scope for leakage and corruption. Low profitability of agriculture, rising input costs, low market prices, inadequate and untimely institutional credit and exorbitant interest rates charged by private moneylenders necessitated this investment support. To cover 72 lakh farmers with ₹ 4,000 per acre per season, the government has to spend ₹ 5,685 crore in *kharif* season. This will save farmers from falling into a debt trap and facilitate purchase of improved seed and fertilizers for higher yields.

Subsidised Sheep

Under this scheme, the State government distributed 45 lakh to over two lakh members of backward communities. Each beneficiary got 20 sheep and a ram. The sheep were also insured, with a separate allocation of ₹ 6 crore. The government also started 100 mobile veterinary clinics with a toll-free number to advise farmers on animal health. Special efforts were also taken to ensure fodder availability, construction of sheds and water tubs by linking the scheme to the Employment Guarantee Scheme. Apart from increasing farmers' income, this scheme will also provide a regular income from the sale of meat and milk.

Coordination Committees

The Telangana Rashtra Rythu Samanvaya Samithi (TRRSS) will be registered as a not-for-profit corporation to support farmers' collective action. It will have village, mandal, district and State-level committees with adequate representation of weaker sections, including women. This is intended to increase collective action by the farmers for better understanding, implementation and better utilisation of government schemes by the farmers and to increase their bargaining power. These committees also promote crop colonies, under which different places are split into crop colonies and federated into State-level to increase the scale of operations. This will enable collaboration and competition with large multinational companies in different agricultural operations like input purchase, contract farming, branding, setting up and maintenance of cold chains and marketing of output.

CONCLUSIONS

Telangana agricultural sector is in a transition from cereal based cropping systems to commercial crops based cropping systems with larger contribution from fruits and vegetables and commercial crops like cotton and soybean. The commercialization of agriculture resulted in high input-high output-high risk for which many small and marginal farmers are not able to cope with and ultimately end up in huge debt with higher cost of production in agricultural sector. Livestock sector growth is also significant, now its contribution is equal to crop sector to gross state domestic product. Telangana agriculture is dominated by small and marginal farmers, whose income from agriculture and allied activities is meager, resulted in most of them shifted to agricultural labourer during the past decade. The number of cultivator's decreased and agricultural labourer increased during the past and this change is more among women (Siddeswari, *et al.* 2020). Farm mechanization increased in the recent years, resulted in increased scale economies with small farmers getting less profit compared to large farmers per unit area. The real problem is as the farm incomes reduced, there was no increase in alternative income sources in rural areas for the farming community. Although many agricultural households engaged in multiple activities like casual labourer, non-farm incomes, but the actual income share from these sources is very limited in Telangana compared to Andhra Pradesh and All-India.

Small and marginal farmers profitability was adversely effected by the rapid spread of farm mechanization, hence there was a need for special programmes to support small farmers' incomes on a long term basis. The input costs are increasing more than gross returns, resulted in decrease in profitability. There was a need for strengthening custom hiring centres in all the villages for easy availability of modern tools and farm equipment to the farmers. The tenant farmers are especially at risk in the event of yield loss or output price reduction, as they have to pay tenancy fee of about 30% of the average farm returns, even though their yields are lower than average. Hence there was an urgent need for addressing the tenancy farmer's problems through institutional innovations and subsidy programmes.

In policy front to facilitate this diversification of agricultural sector, state government should focus on increasing irrigation facilities, providing veterinary services through livestock service centres and rural service centres for promoting overall development of the rural economy to create employment in not only agriculture, but also in off-farm and non-farm activities. However, in this transition period farmers income may fluctuate widely, hence there was a need for price support and crop and livestock insurance for every farmer in Telangana irrespective of the farm size.

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Economics of Sugarcane and Banana Cultivation under Drip Irrigation System: A Case Study of Northern Maharashtra

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ABSTRACT

Efficient development with proper management of the scarce water resources is the key determinants for achieving food security not only for India, but for the entire world. Drip method of irrigation act as the facilitating factors in achieving water saving in irrigation, better quality products, increased water use efficiency, decreased tillage requirement, increased yield of the crop with higher fertilizer use efficiency and investment in drip technologies are also cost effective, with short payback periods. This paper has analyzed and assessed the costs and returns associated with adoption of drip irrigation system under drip irrigation system. The result reveals that cropping intensity is highest among marginal farmers (183.7%) followed by small (164%) and others (116.7%) with an overall cropping intensity of 127.9 per cent. The average gross cropped area was high for large farmers (5.56 ha) followed by small (2.76 ha) and marginal holdings (1.43 ha) as per the expectation. Cropping intensity of non-drip farmers was found to be higher than drip farmers (145%). For both the crops, water consumption was higher in flooding than in drip and yield realization was more in drip method of irrigation. Water consumption in sugarcane was 2339 m^3/ha under drip and 3780 m^3/ha under flood irrigation. On the other hand, yield realization was 1186 q/ha under drip and only 811 q/ha under flood irrigation. Banana crop also consumed less water and produced more yield under drip irrigation over flood irrigation. Adoption of drip saved 26.43 per cent of water used under flood irrigation and increased yield by 46.3 per cent in sugarcane. Similarly, in banana cultivation, 46.4 per cent of water was saved and yield was increased by 16.75 per cent due to use of drip irrigation.

Highlights

- Drip irrigation received considerable attention to the policy makers for its significant contribution towards enhanced agricultural production, resource saving as well as environmentally sustainable.
- Use of drip irrigation technology saves water in sugarcane and banana and hence increases the water productivity.

Keywords: Drip irrigation, cropping intensity, water productivity

In India, demand of water for all the major sectors is growing spontaneously and demand management mechanism becomes the major key strategy to manage scarce resources of water. United Nation reported that with more than 1.3 billion population in 2017, India will be emerging as most populous country by 2024 in the world (UN Revised Population Projections 2017). Since, in India, the foremost water consuming sector is agriculture (78% of fresh water resources), for sustainable management of water resources, the major concern would be the demand management mechanism in water scarce as well as water stressed regions (Kumar 2008). One of the major mechanisms for demand management is adoption of micro irrigation like drip and sprinkler methods of irrigation. In response, the government of India, in conjunction with state governments, has provided capital-cost

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subsidies, ranging over time from 30 per cent to 90 per cent of purchase costs, for potential drip users (Narayanamoorthy, 2008). Drip method of irrigation has immense potential to enhance the productivity of several crops with a reduction in the cost of cultivation. The reason is drip system of irrigation increased benefits through well sponsored central as well as state subsidy schemes. In many corner of India, uncontrolled withdrawal of the groundwater for crop production, supported by subsidization of electricity in farm sector, leads to rapid declines in ground water level (Kumar, 2011). As agriculture sector in India consumes 80per cent of the total fresh water resources; central and state governments is often promoting micro-irrigation as a means to tackle the crisis of ground water resources. India faces recurring droughts in the consecutive years 2012, 2015 and 2016; the micro irrigation is becoming a policy priority. New demand management technologies for water saving such as drip have been introduced in Maharashtra aimed to improve the water use efficiency backed by subsidy programmes. New demand management technologies for water saving such as drip have been introduced in Maharashtra aimed to improve the water use efficiency backed by subsidy programmes. With agricultural intensification and expansion, the demand for water for irrigation purpose has been increasing. This needs efficient management of water resources and micro irrigation methods emerged as one of the effective water-saving technological intervention. Evidences show that in India 86.27 lakh ha area is under micro-irrigation in 2016. Out of which Maharashtra contributes 15.18 per cent (70 per cent drip and 30 per cent sprinkler) area under micro-irrigation (Ministry of Agriculture & Farmers Welfare, GOI, 2016). Though presently Maharashtra ranked second in area under drip method of irrigation in India, only few studies have attempted to find the costs and returns of banana and sugarcane cultivation under drip irrigation. Hence, the present study has concentrated on the economics of sugarcane and banana cultivation under drip irrigation system along with its water productivity and profitability.

MATERIALS AND METHODS

The study is based upon both primary as well as secondary information. Secondary data on micro and drip irrigation in Maharashtra state and India were collected. Farm size-wise beneficiary's farmers for drip irrigation in Maharashtra were collected for selection of districts for primary data collection. Secondary data were collected from various governmental sources like Office of the Commissioner of Agriculture, Pune, Maharashtra, Department of agriculture Nashik and Jalgaon, Ministry of Agriculture & Farmers Welfare, Government of India.

A structured interview schedule was developed to collect primary data from the selected farmers. The data was collected by personal interview method. Data was collected regarding basic information about the farmers, adoption status of drip irrigation system, farmer specific variables, institutional variable, credit availability, source of irrigation, constraints in adoption of drip irrigation, perception on adoption of drip irrigation, forced investment on non-functioning well, ground water table information, employment generation due to adoption of drip irrigation, water market information, information on cost of cultivation etc.

Estimation of water productivity

To estimate the water productivity of drip irrigation technology, tabular analysis was used. The profitability of drip irrigation technology of sugarcane and banana was estimated by employing various farm management cost and return concepts.

Productivity is a measure of system performance expressed as a ratio of output to input. For agricultural systems, Water Productivity (WP) in terms of yield (q/m^3) or in terms of value of output (₹/m^3) is a measure of output of a given system in relation to the water it consumes.

$$WP = \frac{\text{output}\left(\text{q ha}^{-1}\text{or Rs ha}^{-1}\right)}{\text{Water use}\left(M^3\right)}$$

Farm business analysis

In order to assess the profitability of selected sugarcane and banana crops under drip and flood method of irrigation, various costs and return concepts were used.

Cost concepts

Various costs such as Costs A_1 and A_2, Costs B_1 and

B_2 and Costs C_1, C_2 and C_3 were estimated. The details of these cost concepts are given as:

- **Cost A_1**: Wages of hired labour + imputed value of owned and hired bullock labour + charges of hired machinery + Imputed value of owned machinery + market rate of seed, fertilizer + market value of pesticides and other chemicals + Irrigation Charges + Land revenue + Depreciation on farm building and machinery + interest on working capital + miscellaneous expenses
- **Cost A_2**: Cost A_1 + rent paid on leased on land
- Cost **B_1**: Cost A_1 + interest on owned capital excluding value of land
- **Cost B_2**: Cost B_1 + rental value of owned land + rent paid for leased in land
- **Cost C_1**: Cost B_1 + imputed value of family labour
- **Cost C_2**: Cost B_2 + imputed value of family labour
- **Cost C_3**: Cost C_2 + value of management input at 10% of .

Return concepts

The following return concepts were calculated as:

- Farm business income = Gross income – Cost A_1
- Family labour income = Gross income – Cost B_2
- Net income over Cost C_1 = Gross income – Cost C_1
- Net income over Cost C_2 = Gross income – Cost C_2
- Net income over Cost C_3 = Gross income – Cost C_3

Gross income was calculated by adding the value of main product as well as the value of by-product of the particular crop.

RESULTS AND DISCUSSION

Land use pattern

Agriculture is the mainstay of the state Maharashtra. The economy of the state is predominantly agrarian with roughly 56% of the total geographical area under cultivation. Agriculture as main occupation of the people, both food crops as well as cash crops are grown through entire the state. The major principal crops are rice, bajra, jowar, onions, wheat, cotton, pulses, sugarcane, turmeric, and several oil seeds including sunflower, groundnut, and soybean.

Table 1: Land use pattern of Maharashtra state, Jalgaon and Nashik districts

Particulars	**Area ('000 ha)**		
	Maharashtra	**Jalgaon**	**Nashik**
Total geographical area	30758	1164	1563
Net sown Area	17344	849.2	867.5
Area sown more than once	5929	313.6	127.1
Gross Cropped Area	23273	1163	994.6
Forest	5194	155.9	314.8
Cultivable waste land	886	6.3	20.1
Land put to non-agricultural uses	1520	16.2	42.5
Permanent pasture and grazing land	1249	38.7	22.6
Land under miscellaneous tree crops and groves	249	2.8	1.9
Barren uncultivated land	1731	80.4	171
Fallow lands	2587	14.4	14.6
Net irrigated area	3947	213	244
Gross irrigated area	4962	295	311
Cropping intensity (%)	133	137	115

Source: *Commissionerate of Agriculture, GoM.*

The state also has huge areas under fruit cultivation of mango, banana, grape, and orange etc. The net sown area and gross cropped area of the state is 17.3 and 23.2 million hectares respectively. Only 12.5 million hectares is under the permanent pastures reflects the vital for dairying as well as livestock husbandry in the state. The gross and net irrigated area is 4.9 and 3.9 million hectares respectively. Only 23% of the net cropped area is under irrigation which highlights the dependency on rainfall and the risks associated with variability in rainfall patterns observed off late. Area under drip irrigation is 9.24 lakh hectares. The cropping intensity of the region is 133%.

Socio-economic characteristics of sample farms

The general information regarding the socio-economic characteristics of the selected drip and non-drip farmers is presented in Table 2 and 3, respectively. Among the selected drip farmers surveyed the marginal, small and other categories farmers accounted for 13.75, 35.00 and 51.25 per cent, respectively. However, in case of non-drip farmers, marginal, small and other farmers constituted for about 32.5, 50, and 17.50 per cent, respectively. It was found that the majority of the drip farmers were under the category of other farmers (51.25%) and the non-drip farmers were small and marginal (82.5%). The average size of holding for drip farmers was considerably high (3.14 ha) when compared to non-drip farms (1.54 ha).

Table 2: Socio-economic profile of drip irrigated farms

Particulars	Marginal	Small	Others	All
Numbers of farm (No.)	11	28	41	80
Sample farm (per cent)	13.75	35.00	51.25	100
Average size of holding (ha)	0.78	1.69	4.77	3.14
Irrigated area (per cent)	96.67	99.51	96.03	96.66
Area under drip (per cent)	100	96.61	82.80	85.99
Age of head of family (years)	49.91	45.71	46.98	46.94
Farming experience (years)	19.8	17.4	20.50	19.23
Experience in drip irrigation (years)	7.50	7.86	8.26	7.87
Only agriculture as an occupation (%)	95.50	88.20	79.60	87.76
Education level (per cent)				
(a) Upto Primary	27.01	24.10	19.40	23.50
(b) Secondary	36.75	28.80	34.20	33.24
(c) Higher Secondary	19.84	27.50	21.55	22.95
(d) Under graduate	16.40	19.60	22.85	19.61

The farmers who were solely dependent on agriculture was observed to be high in non-drip farmers (96.70%) compared to the drip farmers (87.76%). Nearly, one-fourth of the drip farmers were found to be poorly educated i.e., up to primary, whereas a higher proportion (42%) of non-drip farmers were poorly educated.

Table 3: Socio-economic profile of non-drip irrigated farms

Particulars	Marginal	Small	Others	Overall
Numbers of farm (No.)	13	20	7	40
Sample farm (per cent)	32.50	50.00	17.50	100
Average size of holding (ha)	0.65	1.57	3.09	1.54
Irrigated area (per cent)	62.11	66.78	50.62	66.78
Area under drip (per cent)	—	—	—	—
Age of head of family (years)	49.08	49.1	46.86	48.70
Farming experience (years)	19.85	21.8	19.26	20.30
Only agriculture as an occupation (%)	98.90	96.50	94.70	96.70
Education level (per cent)				
(a) Upto Primary	46.00	44.00	35.38	41.79
(b) Secondary	31.80	26.50	38.20	32.16
(c) Higher Secondary	18.40	21.10	19.57	19.69
(d) Under graduate	3.80	8.40	6.85	6.35

Cropping intensity and pattern

Cropping intensity and pattern on the drip farms in the study area is presented in Table 4. The result reveals that cropping intensity is highest among marginal farmers (183.7%) followed by small (164%) and others (116.7%) with an overall cropping intensity of 127.9 per cent. The average gross cropped area was high for large farmers (5.56 ha) followed by small (2.76 ha) and marginal holdings (1.43 ha) as per the expectation. Sugarcane and banana, other perennial cash crops, were cultivated under drip irrigation, but their cultivation was favoured by large farmers.

Table 4: Cropping intensity and pattern on drip farms

Particulars	Marginal	Small	Others	Overall
Cropping intensity (%)	183.7	164.0	116.7	127.9
Gross cropped area (ha)	1.43	2.76	5.56	4.01
Area under crops (per cent)				
Grapes	—	2.58	27.98	20.49
Banana	—	14.47	9.30	10.09
Sugarcane	5.07	7.24	15.53	13.01
Cotton	27.81	27.39	13.68	17.68
Onion	8.87	12.92	6.84	8.41
Maize (*Kharif*)	17.75	8.01	9.65	9.65
Maize (*Rabi*)	6.34	9.30	6.49	7.16
Wheat	11.33	6.46	6.32	6.60
Chick Pea	7.61	3.10	1.23	1.99
Tomato	—	1.03	0.53	0.62
Others	12.68	3.88	1.75	2.80

The cropping intensity and pattern of non-drip farmers is shown in Table 5. Cropping intensity of non-drip farmers was found to be higher than drip farmers (145%). This was on account of cultivation of more area under seasonal crops and less area under perennial crops.

Table 5: Cropping intensity and pattern on non-drip farms

Particulars	Marginal	Small	Others	Overall
Cropping intensity (%)	164.3	154.1	124.1	145.0
Gross cropped area (ha)	1.06	2.42	3.83	2.23
Area under crops (per cent)				
Banana	0.00	0.00	8.96	2.70
Sugarcane	24.64	15.70	7.46	14.61
Cotton	11.59	31.82	28.36	27.64
Onion	27.54	20.25	8.96	17.98
Maize (*Kharif*)	15.94	17.36	20.90	18.20
Maize (*Rabi*)	0.00	0.00	5.97	1.80
Wheat	0.00	4.13	4.48	3.60
Chick Pea	2.90	4.96	2.99	4.04
Tomato	0.00	1.65	0.00	0.90
Others	17.39	4.13	11.94	8.54

Cropping intensity was found to be highest in case non adopter as compared to drip farms. This can be attributed to the fact that the non-adopters are allocating more area under field cropsand less area under perennial crops like grapes, banana, sugarcane etc.

Water consumption and productivity

Water consumption of drip and non-drip farmers, water saving and increase in yield due to use of drip irrigation in sugarcane and banana cultivation is presented in Table 6. For both the crops, water consumption was higher in flooding than in drip and yield realization was more in drip method of irrigation. Water consumption in sugarcane was 2339 m^3/ha under drip and 3780 m^3/ha under flood irrigation. On the other hand, yield realization was 1186 q/ha under drip and only 811 q/ha under flood irrigation. Banana crop also consumed less water and produced more yield under drip irrigation over flood irrigation. Adoption of drip saved 26.43 per cent of water used under flood irrigation and increased yield by 46.3% in sugarcane. Similarly, in banana cultivation, 46.4 per cent of water was saved and yield was increased by 16.75 per cent due to use of drip irrigation.

Table 6: Water consumption and yield realization of major crops on drip and non-drip farms

Crops	Water consumption (m^3/ha)		Yield (q/ha)		Water saving on drip farms (%)	Yield increase on drip farms (%)
	Drip	Flood	Drip	Flood		
Sugarcane	2339.45	3179.98	1186.2	810.8	26.43	46.3
Banana	4225.89	7884.70	702.7	601.9	46.4	16.75

Water productivity of sugarcane and banana crops in drip and non-drip farms is presented in Table 7. Water productivity in physical quantity and in value of output was found to be more on drip farms than non-drip farms for both sugarcane and banana crops. Water productivity in terms of yield was 0.51q/m^3 on drip farms and 0.25q/m^3 on non-drip farms in sugarcane. In case of banana also, yield was more on drip farms (0.17/m^3) than that of non-drip farms (0.08 q/m^3). Drip farms had water productivity of 124.23 ₹/m^3 and farms irrigated through flooding had 62.47 ₹/m^3 for sugarcane. Similarly for banana crop on drip farms had higher water productivity (99.77 ₹/m^3) than farms practicing flooding (45.8 ₹/m^3).

Table 7: Water productivity of major crops on drip and non-drip farms

Crops	Water productivity: yield (q/m^3)		Water productivity: value of output (₹/m^3)	
	Drip	Flood	Drip	Flood
Sugarcane	0.51	0.25	124.23	62.47
Banana	0.17	0.08	99.77	45.80

Input cost in cultivation of sugarcane crop on drip farms

Total input costs incurred in the sugarcane cultivation is computed and presented in the Table 8. The table revealed that the total input costs were ₹ 150661, ₹ 142117, ₹ 134496 and ₹ 140572 for marginal, small, other and all category of farmers respectively. Hired labour is found to be having the highest (49.4%) share in the total input costs incurred by the farmer. From the perusal of the table, it was observed that family labour costs, seed costs, machinery charges and total input costs decreased with increase in size of holding. On the contrary, hired labour and NPK fertilizer costs continuously increased with the size of holding.

Table 8: Input cost in sugarcane cultivation on drip farms

Particulars	Input cost (₹/ ha)				Share in total inputs cost (%)			
	Marginal	Small	Others	All	Marginal	Small	Others	All
Family labour	14200	13480	12200	12862	9.43	9.49	9.07	9.15
Hired labour	65400	68280	70429	69569	43.41	48.05	52.36	49.49
Machinery charges	12480	10212	8522	9627	8.28	7.19	6.34	6.85
Seed costs	18772	17092	15914	16587	12.46	12.03	11.83	11.80
Irrigation charges	14000	10600	7714	9308	9.29	7.46	5.74	6.62
FYM charges	8000	7904	7226	7998	5.31	5.56	5.37	5.69
NPK charges	17809	14548	12491	14622	11.82	10.24	9.29	10.40
Total inputs cost	150661	142117	134496	140572	100	100	100	100

Farm business analysis of sugarcane cultivation on drip farms

Farm business analysis was utilized to quantify the costs and returns in sugarcane cultivation for the drip farmers and presented in Table 9. The average yield obtained by the cultivation of sugarcane under drip irrigation was 1231 q/ha. Cost C_3 was found to be ₹ 203869 per ha for all the category of farmers and was highest in case of marginal farmers (₹ 232936/ha). Higher Cost C_3 on the marginal farm can be attributed to the relatively higher labour and NPK use and machinery costs per ha. However, net income over cost C_3 was observed to be highest for the other category of farmers (₹ 96492/ha) among all the category of farmers, on account of economies of scale.

Table 9: Costs and returns in sugarcane cultivation on drip farms (₹/ha)

Particulars	Marginal	Small	Others	All
Yield (q/ha)	1280.2	1218.1	1196.3	1231.0
Cost A_1	155786	142152	135867	141730
Cost B_1	171960	147582	144029	149653
Cost B_2	197560	172032	166529	172474
CostC_1	186160	161062	156229	162514
CostC_2	211760	185512	178729	185335
CostC_3	232936	204063	196601	203869
Gross Returns	313649	298435	293094	301592
Farm Business Income	157863	156282	157227	159862
Family Labour Income	116089	126402	126565	129118
Net Income over Cost C_1	127489	137372	136865	139078
Net Income over Cost C_2	101889	112922	114365	116257
Net Income over Cost C_3	80713	94371	96492	97723

Input cost in cultivation of sugarcane crop on non-drip farms

Input cost of sugarcane cultivation under non drip method of irrigation is presented in Table 10. On an average, total input costs for all the category of farmers was found to be ₹ 123845 per ha. Hired labour costs (44.62%) was resulted to be highest contributor among all the input costs incurred to the farmer. Seed value and NPK fertilizer charges accounted for 17.88 and 13.14 per cent of the input costs respectively. FYM costs and the machinery charges were contributing least share with the percentage of 2.35 and 5.15 per cent, respectively. Marginal farmers incurred higher input costs followed by other category and small farmers in sugarcane under flood irrigation.

Farm business analysis of sugarcane cultivation on non-drip farms

Different cost and returns concepts were computed for non-drip cultivation in sugarcane and presented Table 11. Average yield levels for the non-drip farmers were 810.8 q/ha and quite lower than drip farmers. Cost C_3, which is also called as total cost, was found to be ₹ 185423/ha. Marginal farmers incurred higher cost and also realized higher yield levels compared to small and other category of farmers. Family labour and family business incomes on all non-drip farms were observed as ₹ 73179 and ₹ 42366 per ha, respectively. Net income over cost C_3 was least for marginal farmer (₹ 3717/ha) and it increases as the farm size increases.

Input cost in cultivation of banana cultivation on drip and non-farms

The input costs in the cultivation of banana and

Table 10: Input cost of sugarcane cultivation on non-drip farms (₹/ha)

	Input cost (₹/ ha)				Share in total inputs cost (%)			
Particulars	**Marginal**	**Small**	**Others**	**All**	**Marginal**	**Small**	**Others**	**All**
Family labour	16201	12798	8023	12275	12.07	10.53	6.57	9.91
Hired labour	50982	55178	62843	55260	37.98	45.42	51.46	44.62
Machinery charges	7038	6337	5848	6375	5.24	5.22	4.79	5.15
Seed cost	26154	20109	21817	22146	19.49	16.55	17.86	17.88
Irrigation charges	3699	2574	2619	2876	2.76	2.12	2.14	2.32
FYM charges	9358	9087	7299	8635	6.97	7.48	5.98	6.97
NPK charges	20793	15409	13675	16278	15.49	12.68	11.20	13.14
Total inputs cost	134226	121491	122124	123845	100	100	100	100

Table 11: Costs and returns in sugarcane cultivation on non-drip farms (₹/ha)

Particulars	**Marginal**	**Small**	**Others**	**All**
Yield (q/ha)	832.6	805.2	795.3	810.8
Cost A_1	133286	123180	126703	125478
Cost B_1	144263	134696	134189	135502
Cost B_2	165863	155366	154049	156291
Cost C_1	160464	147495	142211	147778
Cost C_2	182064	168165	162071	168566
Cost C_3	200270	184981	178279	185423
Gross Returns	203987	197274	194849	198657
Farm Business Income	70701	74094	68146	73179
Family Labour Income	38124	41908	40800	42366
Net Income over Cost C_1	43523	49779	52637	50879
Net Income over Cost C_2	21923	29109	32777	30090
Net Income over Cost C_3	3717	12293	16570	13234

their share in the total input costs for drip and non-drip farms is presented in Table 12. The average input costs on drip and non-drip farms were ₹ 90901 and ₹ 96984 per ha, respectively. From the perusal of the table, it was found that seed costs was the highest contributor to the total input costs for both the drip (42%) and non-drip (39.96%) farmers.

Table 12: Input cost in Banana cultivation on drip and non-drip farms (₹/ha)

Particulars	**Input cost**		**Share in total inputs cost (%)**	
	Drip	**Non-drip**	**Drip**	**Non-drip**
Family labour	5050	5557	5.56	5.73
Hired labour	16325	18745	17.96	19.33
Machinery charges	6121	4162	6.73	4.29
Seed cost	38400	38752	42.24	39.96
Irrigation charges	8767	11843	9.64	12.21
FYM charges	7000	8132	7.70	8.38
NPK charges	14288	15350	15.72	15.83
Total input costs	90901	96984	100	100

Other major costs were found to be hired labour, NPK costs and FYM costs etc. Hired labour, FYM cost and family labour charges were found to be relatively higher for non-drip farmers. Whereas, only machinery charges was higher for drip farmers in the study area. It is important to note that irrigation charges on non-drip farms were quite higher than drip farms.

Farm business analysis of banana cultivation on drip and non-farms

Farm business analysis of banana cultivation under both drip and non-drip farms is presented in Table 13. The average yield levels of the drip and non-drip farms were found to be 702.7 q/ha and 601.9 q/ha, respectively. The yield levels of non-drip farms were considerably lower than the drip farms. Cost A_1 was higher for non- drip farms (₹ 103093/ha) compared to drip farms (₹ 96769/ha). The returns concepts such as gross returns, farm business income, family labour income and net income over Cost C_3 was observed to be higher for the drip farms compared to non-drip farms.

Table 13: Costs and returns in Banana cultivation on drip and non-drip farms (₹/ha)

Particulars	Drip	Non-drip
Yield (q/ha)	702.7	601.9
Cost A_1	96769	103093
Cost B_1	104692	110523
Cost B_2	128513	131312
Cost C_1	115316	121271
Cost C_2	139137	142060
Cost C_3	153051	156266
Gross Returns	421620	361140
Farm Business Income	319277	252856
Family Labour Income	287533	224637
Net Income over Cost C_1	306304	239869
Net Income over Cost C_2	282483	219080
Net Income over Cost C_3	268569	204874

The average yield levels of the drip and non-drip farms were found to be 702.7 q/ha and 601.9 q/ha, respectively. The yield levels of non-drip farms were considerably lower than the drip farms. Cost A_1 was higher for non- drip farms (₹ 103093/ha) compared to drip farms (₹ 96769/ha). The returns concepts such as gross returns, farm business income, family labour income and net income over Cost C_3 was observed to be higher for the drip farms compared to non-drip farms.

For both the water intensive crop, sugarcane yield was more in marginal farmer as compared to small and others farmers on drip and flood irrigated farms. The possible reason behind this is high resource use efficiency and management efficiency. As farm size increases the cost of family labour has decreased but the cost of hired labour has increased. Irrigation cost is another important cost, this is also higher on marginal farms. Per hectare gross return was more in banana as compared to sugarcane, indicating banana is more profitable than sugarcane because banana is the most important cash crop of the tract. The more input cost of drip farm as compared to non-drip farm in case of banana was due to more hired labour use and increase in irrigation charges. Lower input cost higher returns on drip irrigated farms reflects the higher benefit of adoption of drip irrigation system.

CONCLUSIONS

Drip irrigation received considerable attention to the policy makers for its significant contribution towards enhanced agricultural production, resource saving as well as environmentally sustainable. Cropping intensity on drip farms was lower than non-drip farms on account of cultivation of more area under more water requiring and high value perennial crops. Further, cropping intensity on marginal farms was higher than small and other farms due to cultivation of seasonal crops. Water productivity in yield and monetary terms was found to be almost double under drip irrigation as compared to flood irrigation. Water productivity is the major concern of the study and found to be quite high on drip farms than flooded farms. Farmers can decrease the input cost by adoption of drip irrigation by applying less water, irrigating more area and reduced energy cost and produce higher and quality output. Although, the cost of cultivation was high on drip irrigated farms in comparison to flood irrigated farms on account of higher input use especially labour wages and irrigation cost, the returns realization were also more and impressive on account of higher yields in sugarcane. The returns were also impressive in case of banana cultivation on drip farms than that of non-drip farms. The drip irrigation was found to be economically viable and socially acceptable also. The impressive results costs and returns justify the huge amount of subsidy burden as social cost. In nutshell, integrated and comprehensive efforts are necessary to ensure faster adoption of drip irrigation for conservation of water and energy resources, enhancing quantity and quality of agricultural productivity and improving rural livelihoods.

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Efficiency of Pomegranate Growers: A Data Envelopment Analysis

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ABSTRACT

The present study aims at examining the level of efficiency of Pomegranate growers in Solapur district of Maharashtra which happens to be the leading district in terms of production and area under cultivation of this crop. The variation in the level of efficiency is estimated by using Data Envelopment Analysis (DEA) technique. There is a wide variation in the level of efficiency among the sample farmers for both of orchard age group-II (3rd year to 5th year) and group-III (6th year to 12th year) with mean technical efficiency scores estimated as 69.89 per cent and 85.03 per cent respectively. Thus, there is an opportunity of augmenting production with the available resources in both groups. Pomegranate growers in both groups have been clustered by using K-means cluster analysis in four categories on the basis of their technical efficiency scores as efficient, semi efficient, moderately efficient and poor. An attempt has been made to estimate the excessive amount of inputs used by the Pomegranate growers over the targeted level in the study area. The cost on their excessive inputs can be minimized without affecting output level of particular farms.

Highlights

- In this study for examining the level of efficiency of Pomegranate growers Data Envelopment Analysis (DEA) technique was used.

Keywords: DEA, efficiency, Pomegranate, Solapur etc.

Pomegranate which has greater relative advantage in Maharashtra compare to other regions of the country has a definite commercial status in recent times particularly during the past two-three decades due to increasing urban affluence with changing life style. The state Maharashtra represents one of the leading Pomegranate growing states in India in terms of its area under cultivation recorded as 147910 hectares. This shares 63.22 per cent of total area under this crop in India. Again this state shares 62.90 percent of countries total pomegranate production. (Statistics Division, Department of Agriculture, Coopn & Farmers Welfare 2017-18). Data Envelopment Analysis (DEA) is a mathematical programming approach for estimating the relative Technical Efficiency of production activities. Data Envelopment Analysis was introduced by Farrell (1957) and later on extended by Charnes *et al.* (1978), to incorporate multiple inputs and multiple outputs simultaneously for estimating technical efficiency relative to a production frontier.

Data Envelopment Analysis (DEA) is used to analyze the technical efficiency, i.e. the degree to which a grower uses the minimum feasible amount of resources to produce a given level of output (Coelli *et al*. 2005). Data Envelopment Analysis (DEA) calculates the relative efficiency scores of various Decision-Making Units (DMUs) in a particular farm sample. DEA technique is a non-parametric measure showing performance or

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technical efficiency of an existing technology relative to an ideal "best practice" or frontier technology (Coelli *et al*. 1998). The frontier or best practice technology is a reference technology or production frontier that depicts the most technically efficient combination of inputs and outputs. The frontier technology is formed as a non-parametric, piece wise linear combination of observed -best practice" activities. Data points are enveloped with linear segment and technical efficiency score are calculated relative to the frontier technology.

An assessment of performance of technical efficiency of an existing technology relative to an ideal 'Best Practice' or frontier technology will be helpful to the pomegranate growers for scaling down the scare factors in order to minimize the cost of cultivation of that crop without affecting level of output. Considering the importance of Pomegranate crop in farm economy, the specific objective of study was to analyse the efficiency of selected Pomegranate growers using the input factors.

METHODOLOGY

Simple Random Sampling Without Replacement (SRSWOR) method has been used for selection of sample farmers in this study. Five blocks namely Sangole, Pandharpur, Malshiras, Mangalvedha and Mohol have been selected from Pomegranate cultivating eleven blocks contained in Solapur district. One hundred fifty (150) cultivators representing ultimate sample unit have been chosen from total number of Pomegranate cultivators contains in selected five blocks by SRSWOR. The collected data have been rearranged, processed and analyzed to fulfill the stated objective of the study by employing Data Envelopment Analysis (DEA) technique.

Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is a mathematical programming to construct a production frontier comprising a set of linear segments. The frontier relates to best performance at a point in time. The points separating the segments are forming the best practice Decision Making Unit (DMUs) within a sample. The frontier "envelopes" the entities with the best of output/input ratios. The distance of an inefficient DMU from the frontier is the measure of its inefficiency. For each organization inside the frontier that is found by DEA to be inefficient, the technique identifies at least one DMU on the production frontier. That is a "peer" or role model to the inefficient organization. The technique assigns a wait to each peer reflecting the relevance of that peer to the inefficient DMU.

Briefly, DEA uses mathematical programming to construct a production frontier comprising a set of linear segments. The Frontier relates to the best performance at a point of time and technical efficiency of a DMU (Decision Making Unit) is measured in terms of distance from the frontier. Mathematically the problem DEA is expressed as,

$$\text{Max } \phi,\lambda\ \phi,$$

Subject to,

$$-\phi\, y_i + Y\lambda \geq 0,$$

$$x_i - X\lambda \geq 0,$$

$$N_1'\lambda = 1$$

$$\lambda \geq 0$$

In the above mathematical model, φ can take any value between one and infinity. The proportional increase in output that could be achieved by the i^{th} Pomegranate producing farm or decision making unit (DMU) with input quantities held constant is indicated by (φ-1). Y is ($1 \times N$) the output matrix, λ is ($N \times 1$) vector of intensity variables, X is ($K \times N$) the input matrix, y_i is the output of i^{th} farm, x_i is the input of i^{th} farm, N_1' is a vector of (N×1) and convexity restriction. The ratio of 1/φ defines a technical efficiency score between zero and one (Coelli *et al.* 1998). One output and eight inputs were used in the model. The output is the per hectare yield of pomegranate production in Solapur district. Inputs included are number of plants per hectare, total human labour (days) per hectare, bullock labour (days) per hectare, machine labour (days) per hectare, irrigation (hours) per hectare, manures (tonnes) per hectare, total fertilizers (kg) per hectare and plant protection chemicals (lit) per hectare. A plant protection chemical represents the total amount of insecticides, fungicides, and herbicides etc., used in pomegranate production.

Using k-means cluster analysis Pomegranate growers are classified into four homogenous groups, viz.; efficient, semi efficient, moderate and poor in terms of technical efficiency scores.

RESULTS AND DISCUSSION

Efficiency of selected pomegranate cultivators:

Solapur district in Maharashtra state is dominated by pomegranate crop for a long time. Pomegranate growers of the study area follow more or less same techniques for production but differ widely in terms of output per unit of area. The causes of such variation are owing to differences in the level of efficiency. An attempt has been made to measure the extent of such variation using Data Envelopment Analysis i.e. DEA techniques, which is farm specific influencing production variation. Another objective of using DEA method is to find out the scope for minimizing valuable resources in the disposal of pomegranate growers. The efficiency scores of decision making units i.e. DMUs estimated by DEA for orchard age group II (3rd year to 5th year) and III (6th year to 12th year) are shown in Table 1.

The technical efficiency relates to the degree to which a grower uses the minimum feasible amount of resources to produce a given level of output (Coelli *et al*. 2005). When considering the maximum and minimum values in Table 1, it can be seen that there is a wide variation in the level of efficiency among the sample pomegranate growers for both groups. The mean score level has been estimated as 69.98 per cent for group II and 85.03 per cent for group III. Thus, there is an opportunity of augmenting at least 30 per cent of production in II and 15 per cent for group III with the available farm resources. In other words there is a scope for lifting the inefficient producers belongs to both groups to the level of best practice by increasing the production to the extent of 30 per cent and 15per cent respectively. Similar results were found by Suresh, (2015), Suresh and Chandrakanth (2016) and Kavand and Sargazi (2016).

Additionally, summary statistics for variables used in the efficiency analysis of age group II (3rd year to 5th year) and III (6th year to 12th year) are presented in Table 2.

Table 1: Efficiency scores of DMUs by DEA method for group II and III

Sl. No.	Technical Efficiency		Sl. No.	Technical Efficiency		Sl. No.	Technical Efficiency	
	II	III		II	III		II	III
1	0.536	1.000	26	0.466	1.000	51	0.621	1.000
2	0.588	1.000	27	0.413	1.000	52	0.358	0.783
3	0.458	1.000	28	0.732	0.893	53	0.689	0.724
4	0.496	1.000	29	1.000	0.794	54	0.732	1.000
5	0.322	1.000	30	0.784	0.828	55	0.554	0.885
6	0.317	0.611	31	0.572	0.852	56	1.000	0.799
7	0.496	0.863	32	0.790	0.877	57	0.909	0.937
8	0.497	0.860	33	0.696	0.894	58	0.874	0.742
9	0.553	0.852	34	0.699	0.880	59	0.753	0.789
10	0.636	1.000	35	1.000	0.922	60	0.797	0.733
11	1.000	0.852	36	0.625	1.000	61	1.000	0.706
12	0.651	1.000	37	0.640	0.652	62	0.959	0.558
13	0.651	1.000	38	0.805	1.000	63	1.000	0.444
14	0.720	0.672	39	1.000	0.844	64	0.968	0.672
15	0.552	0.679	40	0.875	1.000	65	0.928	0.672
16	0.695	0.709	41	0.946	0.780	66	1.000	0.733
17	0.525	0.847	42	0.990	1.000	67	1.000	0.587
18	0.513	0.786	43	0.782	0.979	68	0.630	0.634
19	0.456	0.864	44	0.629	0.858	69	0.794	0.519
20	0.386	0.709	45	0.797	0.877	70	1.000	1.000
21	0.564	0.980	46	0.457	0.850	71	0.787	1.000
22	0.524	1.000	47	0.773	0.937	72	0.633	0.963
23	0.380	0.757	48	0.559	0.839	73	0.564	0.984
24	0.477	1.000	49	0.503	0.610	74	0.903	0.940
25	0.553	1.000	50	0.880	0.763	75	1.000	1.000

Mean - Group II: 0.699 and Group III: 0.850.

Table 2: Summary statistics for variables used in the efficiency analysis of group II (3rd year to 5th year) and III (6th year to 12th year)

Variables	Mean	Min.	Max.	Std. deviation
Orchard age group II				
Pomegranate Yield (tonnes /ha)	8.00	4.13	13.92	2.22
Planting Material (No of Plants/ Ha)	738.07	662.21	799.00	23.19
Total Human Labour (Days)	277.25	86.00	982.00	143.10
Bullock Labour (Days)	20.40	9.89	43.29	6.66
Machine labour (Days)	7.05	3.06	13.46	2.35
Irrigation (hrs)	111.40	57.00	333.15	46.87
Mannures (tonnes)	11.01	8.10	14.70	1.60
Total Fertilizres (Kg)	1341.12	1083.47	1758.75	129.47
Plant Protection chemicals (Lit)	645.17	127.50	1626.71	205.50
Orchard age group III				
Pomegranate Yield (tonnes /ha)	9.31	5.31	13.31	1.65
Planting Material (No of Plants/ Ha)	700.64	677.54	712.20	5.26
Total Human Labour (Days)	169.89	72.00	288.00	45.79
Bullock Labour (Days)	15.45	4.98	30.53	5.36
Machine labour (Days)	5.69	2.91	10.39	1.94
Irrigation (hrs)	175.15	52.46	582.75	107.18
Mannures (tonnes)	11.91	9.65	15.30	1.07
Total Fertilizres (Kg)	1444.94	1070.00	1991.25	164.83
Plant Protection chemicals (Lit)	897.56	439.31	2426.83	319.92

Table 3: Distribution of sample DMUs according to level of technical efficiency for group II and III

Particulars	Cluster I (Poor)		Cluster II (Moderate)		Cluster III (Semi efficient)		Cluster IV (Efficient)	
Age group	II	III	II	III	II	III	II	III
Technical Efficiency	0.408	0.526	0.571	0.692	0.754	0.843	0.963	0.988
No. DMUs	11	04	26	17	17	24	21	30
Number of farms under different size groups								
Small	00	00	00	00	08	11	16	22
Medium	01	00	09	08	09	13	05	08
Large	10	04	17	09	00	00	00	00

Note: *Number of farms in group II and group III are 75 each.*

When considering the maximum and minimum level of inputs used in the efficiency analysis, it is observed that there is a wide variation in the level of application of inputs in the sample farms. Distribution of pomegranate growers into four distinct groups according to level of technical efficiency for both groups of sample pomegranate farmers Adhikari *et al.* (2012), Bhatt and Bhatt (2014), Ray *et al*. (2016) and Singh and Kaur (2014) and it has been presented in Table 3.

Table 3 shows that, out of 75 farmers in group II, 21 farmers which accounts for 28 per cent belong to efficient cluster. Similarly 30 farmers in group III show their efficiency which is accounted for 40 per cent of the sample pomegranate growers belongs to the efficient cluster. It is also seen that maximum number of DMUs of group II comes under moderately efficient category with mean efficiency 0.57. On the other hand maximum number of DMUs of group III comes under efficient category with mean efficiency 0.98. It is also estimated that 50.66 per cent of sample units from group II belongs to semi efficient and efficient category and 72 per cent from orchard age group III. It is also estimated that 14.66 per cent and 5.33 per cent of group II and group III in poor category farms can be improved by augmenting output with 60 per cent and 58 per cent respectively. Similarly 34.66 and 22.66 per cent moderate category farmers can increase output by 43 and 31 per cent of group II and III respectively, with the existing level of resources.

Group-wise average inputs used and possibilities

Table 4: Group-wise average inputs used and possibilities of minimization for orchard age group II (3rd year to 5th year)

Cluster Groups	Planting Material		Human Labour		Bullock Labour		Machine labour		Irrigation		Mannures		Fertilizres		Plant Protection	
	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target
Poor	734.54	681.08	289.82	212.52	22.10	18.07	7.88	6.54	108.88	107.01	11.54	9.96	1339.78	1208.02	690.06	595.71
Moderate	734.15	695.67	299.04	257.49	20.19	16.49	6.72	5.81	128.50	128.15	11.60	10.20	1384.32	1263.54	635.28	571.90
Semi efficient	752.46	714.70	213.67	187.56	22.76	19.78	7.50	7.06	97.40	97.25	10.52	9.32	1335.94	1243.99	613.46	568.43
Efficient	737.45	710.76	327.73	302.60	17.23	15.73	6.06	5.74	106.34	106.34	10.40	9.85	1291.41	1236.00	609.24	573.68

Table 5: Group-wise average inputs used and possibilities of minimization for orchard age group III (6th year to 12th year)

Cluster Groups	Planting Material		Human Labour		Bullock Labour		Machine labour		Irrigation		Mannures		Fertilizres		Plant Protection	
	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target	Used	Target
Poor	701.41	651.73	215.75	178.41	16.32	14.80	5.94	5.16	179.93	166.14	11.98	10.93	1440.61	1295.99	882.33	713.93
Moderate	697.30	690.17	184.76	162.47	16.70	15.43	6.24	5.61	167.74	143.63	12.26	11.52	1461.26	1378.96	1038.82	981.54
Semi efficient	702.81	700.35	159.71	142.12	13.32	12.19	4.44	3.97	151.14	139.79	12.05	11.43	1453.33	1416.02	951.87	894.84
Efficient	697.45	697.45	152.93	151.97	15.17	15.15	5.68	5.63	160.14	159.21	11.45	11.35	1416.78	1409.90	886.88	876.61

of critical input without loss of current level of production reduction for group II and III has been shown in Table 4 and 5. A wide variation between used and targeted amount of inputs has been found in all cluster groups for the orchard age group II. The similar variation has also seen in case of group III.

An attempt has been made to analyze the slack variables which indicate the excessive amount of inputs used by the pomegranate growers over the targeted level in the study area (Ozalp and Yilmaz 2015). Mean of actual amount of inputs used and their slacks of the group II and III are presented in Table 6.

Table 6: Distribution of input slacks and number of farms using excess inputs for group II and III

Inputs	Numbers of farms	Mean slack	Mean input use	Excess input use (%)
Orchard age group II				
Planting Material (No of Plants/ Ha)	43	37.68	738.07	5.10
Total Human Labour (Man Days)	40	42.92	277.33	15.47
Bullock Labour (Days)	48	3.09	20.40	15.14
Machine labour (Days)	33	0.83	7.05	11.77
Irrigation (hrs)	3	0.78	111.40	0.70
Mannures (tonnes)	51	1.07	11.01	9.71
Total Fertilizres (Kg)	42	147.21	1341.12	10.97
Plant Protection chemicals (Lit)	29	65.12	645.17	10.09
Orchard age group III				
Planting Material (No of Plants/ Ha)	31	20.11	700.64	2.87
Total Human Labour (Man Days)	34	14.17	169.89	8.34
Bullock Labour (Days)	21	0.81	15.45	5.24
Machine labour (Days)	32	0.45	5.69	7.90
Irrigation (hrs)	28	0.95	175.15	0.54
Mannures (tonnes)	45	0.65	11.91	5.45
Total Fertilizres (Kg)	42	77.48	1444.94	5.36
Plant Protection chemicals (Lit)	16	72.68	897.56	8.09

The excessive inputs used in total human labour and bullock labour are found to be maximum in group II (3rd year to 5th year) as revealed by the Table 5.25. In other words it can be said that farm can minimize human labour and bullock labour use by 15.47 per cent and 15.14 per cent respectively. Thus, there are ample scope of minimizing 42.92 man days per hectare and 3.09 bullock pair days without curtailing existing output. This will lead to saving labour as well as reducing input costs. It is also estimated that 53.33 per cent man days and 64 per cent for bullock labour days of DMUs have potential for scaling down in group II. In the same way the particular farm can minimize their machine labour use by 11.77 per cent. As well, in case of manures and fertilizers there is scope for decreasing their quantum by the amount of mean slack i.e., on an average of individual pomegranate grower possess the potential for cutting down manure amount by 1.07 tonnes per hectare and 147.21 kg fertilizers per hectare. Automatically costs on these inputs can be decreased without affecting output level of particular farms. Optimum use of irrigation is witnessed in study area because majority of pomegranate growers are using drip irrigation system for irrigating the orchard. Similarly the excess use of human labour followed by plant protection chemicals and machine labour is found to be high in the farms belong to group III. Therefore, the particular farms may curtail their 8.34 per cent human labour, 8.09 per cent plant protection chemicals and 7.90 per cent machine labour while maintaining the same level of output. Thus, there is a good opportunity of curtailing 14.17 man days per hectare and 72.68 lit plant protection chemicals which leads to diminishing input costs. A farm can reduce its expenditure on key inputs like manures and fertilizers by 5.45 per cent and 4.36 per cent amount for particular slack variable. In the same way the particular farm can minimize their bullock labour use by 5.24 per cent and number of plants per hectare by 2.87 per cent. Hence costs on these excessively used inputs can be decreased without affecting output level of particular farms.

CONCLUSION

The study conclude that there is a wide variation in the level of efficiency among the sample farmers for both of orchard age group-II (3rd year to 5th year) and group-III (6th year to 12th year). So, there is ample scope for saving critical inputs. Overall technical efficiency suggests that the average farm can reduce its amount of input usage without reducing its output. This can be achieved by improving farm technologies and managing improper input use. In group II and III 28 per cent and 40 per cent farmers belong to efficient cluster respectively. Similarly, it is also seen that maximum number of Decision Making Unit's (DMUs) of group-II comes under moderately efficient. In group-III, the maximum number of DMUs comes under efficient. The estimated mean efficiency in poor category farms reveals that 14.66 per cent of group-II and 5.33 per cent of group-III farms belong to poor category can be improved by augmenting output by 60 per cent and 58 per cent respectively. A farm can reduce its spending on a particular input to the tune of the amount of that slack variable, without dropping its production level.

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Awareness and Performance of Agricultural Development Schemes in Context of Farmers' Welfare in Haryana

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ABSTRACT

The Government of India have introduced the innovative schemes of crop insurance however; most of the farmers are unaware of it. Therefore, it is necessary to check the awareness and performance of farmers about crop insurance and agricultural development schemes in Hisar and Fatehabad districts of Haryana state. Data was collected via interview schedule from 100 farmers selected randomly from these two districts. The study revealed that 86 per cent of the farmers were found aware about the crops included under Pradhan Mantri Fasal Beema Yojana (PMFBY) followed by premium paid for insurance of the crops (72 %). The data regarding awareness of Pradhan Mantri Krishi Sinchai Yojana (PMKSY) showed that more than half of the respondents had aware about PMKSY. However, majority of respondents (above 64 %) were found not aware about subsidy pattern under scheme and additional benefits for small farmers. Performance of agricultural development schemes predicts that majority of the respondent (87 %) viewed that is performing well. Only 13 per cent of the respondents viewed that the scheme is performing not so good. In case of PMKSY, majority of the respondents (72 %) had opinion that the scheme is performing good. About half of the respondents (52 %) viewed that Agricultural Mechanization for *In-Situ* Crop Residue Management is performing good. The awareness regarding promotion of Agricultural Mechanization for *In-Situ* Crop Residue Management (CRM) indicated that two-third respondents had awareness about the scheme and 62 per cent of them agreed that custom hiring centre established under the scheme.

Highlights

- The main problem is to check the awareness and performance of farmers about crop insurance and agricultural development schemes in Hisar and Fatehabad districts of Haryana state.

Keywords: Awareness, crop insurance scheme, performance, Pradhan Mantri Fasal Bima Yojana

Agriculture is the largest and most important sector of the Indian economy. Nearly 70 percent of population are depending upon agriculture for their livelihood and employment. Farm agricultural development is essential to overall economic progress. Due to Dependence on weather and biological uncertainties in managing crops, the agriculture production fluctuates in India and thus has direct impact on both the national income and the farmers or the cultivators (Nidhi Shanker, 2018). The risk burden of the farmers can be reduced through crop insurance, which is primarily a way of protecting farmers against the element of chance in crop production. Due to the natural calamities the agricultural production, gross national product and also the income of the farmers decrease. The sector is facing manifold problems such as crop failures, non-remunerative prices for crops and poor returns on yield. Agrarian distress is so severe, that it is

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pushing many farmers to despair about 39 percent of the cases of farmer suicides were attributed to bankruptcy and indebtedness in 2015 according to the ADSI report (Accidental Deaths and Suicides in India (Rep). Crop insurance spreads the crop losses over space and time, provides social security to the farmers, helps in maintaining their dignity, offers self-help, encourages large investments in agriculture for improving crop yield and increasing agricultural production (Singh, 2004). It was also reported that almost more than half of the progressive farmers were aware regarding the various aspects of PMFBY but there is a need to make the famers aware about crop/weather insurance through awareness programme (Wahab Zada *et al*. 2019). To escape from natural calamities and farmer suicides, awareness of crop insurance scheme is essential for the farmers. It helps in stabilization of farm production and income of farming community. It helps in optimal allocation of resources in the production process. But farmers are not willing to take crop insurance because they thinks there may be corruption at the time of compensation, it will be lengthy process and the services of financial institutions are not satisfactory. Rajaram and Chetana (2018) also observed that the farmers are unaware of market related information. Keeping these points in mind, the study was conducted to assess the farmers' awareness towards government agricultural development schemes and the performance of government agricultural development schemes.

METHODOLOGY

The study was conducted in Hisar and Fatehabad district of Haryana state in 2018-19. Thus, 100 farmers were selected randomly and interviewed from villages namely, Sarsod, Bichpuri, Behbalpur, Badonpatti & Dhansu of Hisar district and Dangra, Jandli Kalan, Chandrawal, Hasanga & Gorakhpur of Fatehabad district. The statistical measures like mean, frequency, percentage and rank order, etc. were used to draw meaningful inferences. Aggregate total score were calculated based on calculated score. A weighted mean score was obtained and the maximum weighted mean score so obtained were given the rank 1st and the next subsequent one was given 2nd and so on the descending orders.

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that more than half of the respondents (58%) belonged to the middle age group (31-50 years) followed by young (up to 30 years) to the extent of 28 per cent. The remaining 14 per cent of the respondents belonged to old age group (51 years and above). Desai also found more than half of groundnut growers (57%) belonged to middle age group.

Table 1: Personal profile of respondents (n = 100)

Sl. No.	Variables	Category	Frequency	Percentage
1	Age	Young (up to 30)	28	28.00
		Middle (31-50 years)	58	58.00
		Old (51 and above)	14	14.00
2	Education	Illiterate	06	06.00
		Primary	12	12.00
		Middle	18	18.00
		Matriculation	32	32.00
		Higher secondary	24	24.00
		Graduate	06	06.00
		Post graduate	02	02.00
3	Land holding	Landless	00	00.00
		Less than 1 acre	06	06.00
		Above 1 and up to 5 acres	42	42.00
		Above 5 and up to 10 acres	36	36.00
		Above 10 to 15 acres	12	12.00
		Above 15 acres	04	04.00

The data also reported that about one-third of respondents (32%) were matriculate followed by 24 per cent, 18 per cent, 12 per cent, 6 per cent, 2 per cent higher secondary, middle, primary, graduate and illiterate, respectively. Only 2 per cent of the respondents having post graduate educational qualification.

As for as land holding of respondents is concerned, maximum respondents i.e. 48 per cent were having land up to 5 acres. About one-third of the respondents (36 %) were having land holding ranged from 5 to10 acres. The remaining 16 per cent respondents possess land holding more than 10 acres.

Table 2: Distribution according to owned farm implements by the farmers (n = 100*)

Sl. No.	Farm implements	Frequency	Percentage
1	Tractor	38	38.00
2	Harrow	36	36.00
3	Cultivator	32	32.00
4	Seed cum fertilizer drill	28	28.00
5	Laser land leveler	04	04.00
6	Combine harvester	02	02.00
7	Puddler	12	12.00
8	Rotavator	24	24.00
9	Happy seeder	04	04.00
10	Sprayer (Knap Sack)	88	88.00
11	Tractor mounted spray pump	24	24.00
12	Straw Reaper	06	06.00

**Mutliple responses.*

The data in table 2 represents that about one-third of the respondents (38 %) owned tractor followed by harrow (36 %), cultivator (32 %), seed cum fertilizer drill (28 %), rotavator (24 %), tractor mounted spray pump (24 %), and puddler (12 %), respectively. The table 2 also showed that only 4 per cent respondents owned happy seeder, 6 per cent straw reaper, 4 per cent laser land leveller and 2 per cent combine harvester. A majority of respondents (88 per cent) owned knap-sack sprayer.

Table 3: Irrigation facilities available with the respondents (n = 100*)

Sl. No.	Modes of irrigation	Frequency(s)	Percentage(s)
1	Submersible pump	56	56.00
2	Tube Well	38	38.00
3	Canal	85	85.00

**Mutliple responses*

Table 4: Distribution of respondents according to their farming system (n = 100)

Sl. No.	Farming system	Frequency	Percentage
1	Livestock	88	88.00
2	Bee keeping	04	04.00
3	Agro-Forestry	08	08.00
4	Organic farming	03	03.00
5	Mushroom cultivation	02	02.00
6	Polyhouse vegetable production	04	04.00
7	Integrated farming system	02	02.00

The data in table 3 revealed that more than half of the respondents (56 %) had irrigation facilities of submersible pump followed by tube well (38 %). A total of 85 per cent of the farmers were using canal water for irrigation.

Multiple response

The data in table 4 revealed that majority of respondents (88 %) were doing livestock practices followed by agro-forestry (8 %), bee keeping (4%), polyhouse vegetable production (4 %), organic farming (3 %), integrated farming system (2 %) and mushroom cultivation (2 %), respectively in their farming system.

Table 5: Cropping Pattern and crop rotation (n = 100)

Sl. No.	Farming system	Frequency	Percentage	Crop rotation	Frequency	Percentage
1	Multiple cropping	100	100.00	Paddy-Wheat	48	48.00
				Cotton-Wheat	30	30.00
				Wheat-Summer moong-Paddy	08	08.00
				Bajra/Guar/Jowar-Mustard/ Wheat	12	12.00
				Paddy-other crops (Veg.)	02	02.00

The data in table 5 indicated that all the respondents (100%) using multiple cropping system at their farms. As for as crop rotation is concerned, about half of the respondents (48 %) had paddy-wheat crop rotation followed by cotton-wheat (30 %), bajra/guar/jowar/mustard/wheat (12 %) and wheat-summer moong-paddy (8 %), respectively. Only 2 per cent of the respondents were using paddy-other crops (veg. crops) at their farms.

It is indicated from the table 6 that viewing of Television ranked first with weighted mean score of 1.68 followed by reading newspaper ranked second, listening radio ranked third, online solution ranked fourth, reading magazines ranked fifth and visit of Kisan Sewa Kendra ranked sixth with weighted mean score of 1.01, 0.68, 0.30, 0.20 and 0.13, respectively for seeking information.

It is revealed from the table 7 that among the extension contact of farmers, the most popular were the progressive farmers with weighted mean score

Table 6: Mass Media Exposure (n = 100)

Sl. No.	Mass media	Used	Extent of utilization			Total score	Weighted mean score	Rank order
			Daily (3)	Often (2)	Sometimes (1)			
1	Radio	40 (40.00)	04(12)	20(40)	16(16)	68	0.68	III
2	TV	78 (78.00)	34 (102)	22 (44)	22 (22)	168	1.68	I
3	Newspaper	40 (40.00)	23 (69)	15(30)	02(2)	101	1.01	II
4	Magazines	10 (10.00)	02 (6)	06 (12)	02 (2)	20	0.20	V
5	Kisan Sewa Kendra	06 (06.00)	02 (6)	03(6)	01 (1)	13	0.13	VI
6	Online solution	14 (14.00)	05 (15)	06 (12)	03 (3)	30	0.30	IV

Table 7: Extension contact (n = 100)

Sl. No.	Extension Official	Frequency of contact				Total score	Weighted mean score	Rank order
		Weekly (4)	Fortnightly (3)	Monthly (2)	Whenever Needed (1)			
1	ADO	15 (60)	20(60)	22(44)	38 (38)	202	2.02	II
2	SDAO/SMS	8 (32)	18 (54)	10(20)	52(52)	158	1.58	III
3	Scientists	8 (32)	12(36)	06(12)	44(44)	124	1.24	IV
4	Progressive farmers	26(104)	15(45)	19(38)	38(38)	225	2.25	I
5	Others	02(8)	4(12)	6(12)	62 (62)	94	0.94	V

2.25. ADO and SDAO/SMS ranked second and third with weighted mean score of 2.02 and 1.58 followed by scientists and others ranked at fourth and fifth with weighted mean score 1.24, 0.94, respectively.

The data regarding farmers' awareness about agricultural development schemes presented in table 8 predict that 86 per cent of the farmers were aware about the crops included under PMFBY followed by 72 per cent had awareness about the premium paid for insurance of the crops. 89 per cent of the respondents had knowledge that PMFBY is mandatory for loanee farmers. The data regarding awareness of PMKSY showed that more than half of the respondents had awareness about PMKSY. However, large majority the respondents (above 64 %) were not aware about subsidy pattern, sealing of area under scheme and additional benefit for small and marginal farmers.

Seventy two per cent of respondents were not aware about e-NAM facility. In case of ATMA scheme, majority of the respondents (72 %) were aware about the scheme and 68 per cent were aware about its implementing agency at district level. . More than half of the respondents had awareness about NFSM. The data regarding awareness of Mission on Integrated Development of Horticulture (MIDH Sub component-NHM) revealed that 53 per cent of the respondents were aware about MIDH. 40 per cent of them know about the components covered under the scheme. About one-third (36 %) of the respondents had awareness about subsidy pattern being followed for the components covered under the scheme.

As for as soil health card scheme is concerned, the respondents had awareness to the extent of 68 per cent. More than half of the respondents (56 %) know about the benefits of the scheme.

The awareness regarding promotion of Agricultural Mechanization for *In-Situ* Crop Residue Management (CRM) presented in table 8 indicated that two-third respondents had awareness about the scheme and 62 per cent of them knows that custom hiring centre established under the scheme. More than half of the respondent (58 %) knows about the assistance being provided by the government on farm machineries under the scheme for crop residue management. A total of 65 per cent of the respondents were aware that trainings /extension programmes are organized under the scheme.

Majority of the sampled farmers/respondents were not aware about Prampragat Krishi Vikas Yojana (PKVY) and Small Farmers Agri-business Consortium (SFAC). Only few (less than 15%) were aware about the PKVY & SFAC.

Table 8: Farmers' Awareness about Agricultural Development Schemes (n = 100*)

Sl. No.	Statements	Degree of Awareness			
		Aware		Not Aware	
		f	%	f	%
1	**Pradhan Mantri Fasal Beema Yojana**				
(a)	Awareness about crops included under the scheme	86	86.00	14	14.00
(b)	Awareness about premium of crops	72	72.00	28	28.00
(c)	Knowledge that PMFBY is mandatory for Loanee farmers	89	89.00	11	11.00
2	**Pradhan Mantri Krishi Sinchai Yojana (Per Drop More Crops)**				
(a)	Awareness about PMKSY	56	56.00	44	44.00
(b)	Awareness about subsidy pattern for micro irrigation	35	35.00	65	65.00
(c)	Knowledge about sealing of area under the scheme for availing benefits	32	32.00	68	68.00
(d)	Knowledge about additional benefits for Small & marginal farmers under the scheme	36	36.00	64	64.00
3	**Awareness about e-NAM facility**	28	28.00	72	72.00
4	**Agricultural Technology Management Agency (ATMA)**				
(a)	Awareness about ATMA scheme	72	72.00	28	28.00
(b)	Awareness about implementing agency	68	68.00	32	32.00
5	**National Food Security Mission (NFSM)**				
(a)	Awareness about NFSM scheme	58	58.00	42	42.00
(b)	Awareness about implementing agency	52	52.00	48	48.00
6	**Mission on Integrated Development of Horticulture (MIDH Sub component-NHM)**				
(a)	Awareness about MIDH	53	53.00	47	47.00
(b)	Awareness about implementing agency	48	48.00	52	52.00
(c)	Awareness about the components of the scheme	40	40.00	60	60.00
(d)	Awareness about subsidy pattern under the scheme	36	36.00	64	64.00
7	**Soil Health Card Scheme**				
(a)	Awareness about SHC	68	68.00	32	32.00
(b)	Awareness about benefit of SHC	56	56.00	44	44.00
8	**Promotion of Agricultural Mechanization for *In-Situ* Crop Residue Management**				
(a)	Awareness about the scheme	70	70.00	30	30.00
(b)	Knowledge about Custom Hire Centre	62	62.00	38	38.00
(c)	Knowledge that assistance is being provided on farm Machinery under the scheme	58	58.00	42	42.00
(d)	Awareness about programmes/trainings organized under the scheme	65	65.00	35	35.00
9	**Prampragat Krishi Vikas Yojana (PKVY)**				
(a)	Awareness about the scheme	36	36.00	64	64.00
(b)	Awareness about implementing agency	32	32.00	68	68.00
(c)	Awareness about purpose of scheme	28	28.00	72	72.00
(d)	Knowledge about assistance given for promotion of organic farming under the scheme	16	16.00	84	84.00
10	**Small Farmers Agri-business Consortium (SFAC)**				
(a)	Awareness about the scheme	32	32.00	68	68.00
(b)	Awareness about implementing agency	26	26.00	74	74.00
(c)	Awareness about purpose of scheme	14	14.00	86	86.00

**Multiple responses.*

The data in table 9 regarding performance of agricultural development schemes predict that majority of the respondent (87 %) is of view that Pradhan Mantri Fasal Beema Yojana is performing well. Only 13 per cent of the respondents viewed that the scheme is performing not so good. In case of Pradhan Mantri Krishi Sinchai Yojana (Per Drop More Crops) is concerned, majority of the respondents (72.00%) had opinion that the scheme is performing good. The poor performance was observed in case of e-NAM facility provided by the government as 85 per cent of the respondents

Table 9: Perception of respondents towards performance of Agricultural Development Schemes (n = 100*)

Sl. No.	Statements	Degree of Performance			
		Good		Not so good	
		Frequency	Percentage	Frequency	Percentage
1	Pradhan Mantri Fasal Beema Yojana	87	87.00	13	13.00
2	Pradhan Mantri Krishi Sinchai Yojana (Per Drop More Crops)	72	72.00	28	28.00
3	e-NAM	15	15.00	85	85.00
4	Agricultural Technology Management Agency (ATMA)	64	64.00	36	36.00
5	National Food Security Mission (NFSM)	52	52.00	48	48.00
6	Mission on Integrated Development of Horticulture (MIDH Sub component-NHM)	50	50.00	50	50.00
7	Soil Health Cards	38	38.00	62	62.00
8	Agricultural Mechanization for *In-Situ* Crop Residue Management (CRM)	52	52.00	48	48.00
9	Prampragat Krishi Vikas Yojana (PKVY)	12	12.00	88	88.00
10	Small farmers Agri-business Consortium (SFAC)	16	16.00	84	84.00

**Multiple responses.*

viewed that performance is not so good.

The data in table 9 also indicates that 64 per cent, 52 percent and 50 percent of the respondents viewed that ATMA, NFSM and MIDH schemes respectively performing good. About half of the respondents (52 %) viewed that the scheme for promotion of Agricultural Mechanization for *In-Situ* Crop Residue Management is performing good. Majority of the sampled farmers viewed that the schemes like Prampragat Krishi Vikas Yojana (PKVY), Small farmers Agri-business Consortium (SFAC) and Soil Health Cards are performing not so good.

CONCLUSIONS

It is concluded that 86 per cent of the farmers were aware about the crops included under PMFBY followed by 72 per cent had awareness about the premium paid for insurance of the crops. Seventy two per cent of respondents were not about e-NAM facility. As for as soil health card scheme is concerned, the respondents had awareness to the extent of 68 per cent. More than half of the respondents (56 %) know about the benefits of the scheme. Regarding performance of agricultural development schemes; majority of the respondents were of view that Pradhan Mantri Fasal Beema Yojana, Pradhan Mantri Krishi Sinchai Yojana (Per Drop More Crops) is performing good. 64 percent, 52 percent and 50 percent of the respondents viewed that ATMA, NFSM and MIDH schemes respectively are also performing good.

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Decomposition Analysis for Impact of Backward Integration on Input Use Pattern and Profitability of Chilli Farmers in Andhra Pradesh

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ABSTRACT

The present study find out the was impact of backward integration on chilli farmers in terms of input use pattern and profitability in Andhra Pradesh. Multistage random sampling was selected adopted for the sample selection. A total of 128 sample were taken. Two major Agribusiness firms, i.e., ITC and Synthite that are following backward integration in chilli farming in Prakasam district were purposively selected for the study. The decomposition analysis showed that the per hectare returns of integrated farming was 13.28 per cent higher than that of non-integrated farming. The integrated technology component was contributing 3.7 per cent to the total increase in output. The total contribution of changes in the levels of input use to the outcome differences between the two groups was 9.58 per cent.

Highlights

- Decomposition analysis was used to analyse the impact of backward integration on input use pattern and profitability of chilli farmers, the farmers who are following backward integration are getting higher income than farmers who are not following backward integration.

Keywords: Backward integration, Chilli, Andhra Pradesh, Decomposition analysis

Backward integration is a strategy where a firm gains control over ownership or increased control over its suppliers. It basically comprises of four components, pre-agreed price, quality, quantity and time. It was an approach that can bring income for farmers and profitability for companies (Sharma *et al.* 2014). The potential for increasing exports of whole chillies, crushed chillies and chilli powder in consumer packs is very high, provided the stringent quality requirements of importing countries are met. The consumers in the importing countries insist on 'clean spices' and to meet this challenge, efforts are to be made to prevent contamination from external sources during application of plant protection chemicals, harvesting, post-harvest handling, processing and storage. It is vitally important to support the chilli farmers to produce high quality sustainable food safe spices to compete in the international market. This can be achieved by an integrated approach with the collective efforts of farmers, processors and traders. The agribusiness firms which are mainly engaged with chilli processing are providing extension services to chilli farmers regarding integrated technologies to improve the quality of produce. The major players like ITC and C, Synthite viz., are providing customised solutions to diverse challenges of chilli farmers through backward integration by providing

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integrated pest management practices, transport facilities, packing materials and storage facilities. In addition to all these facilities, these agribusiness firms providesing technology transfer through extension services. Gawaria *et al.* (2010) studied decomposition analysis of output change under new wheat technology in arid region of Rajasthan. The results revealed that the total difference in productivity between modern and traditional technology was estimated to be about 62 per cent. The modern technology increased the production by 62.30 per cent over the traditional variety and the difference in varietal technology contributing nearly 46 per cent, while remaining 14 per cent was shared by complementary inputs. In present study, the farmers who are following backward integration are integrated farmers and rest of the farmers are non-integrated farmers. Mohan (2009) studied the impact of IPM technology in Haveri district, Karnataka. The results of decomposition analysis showed that total difference in output between IPM and non-IPM was 28.47 per cent in total and IPM technology component alone contributed 19.86 per cent.

Wide variation in yield levels in chilli resulting in fluctuation in prices and farmers are facing problems like high transportation cost, viral diseases, quality deterioration by contamination of pesticides, industrial chemicals and aflatoxins (Rao and Rao, 2014). It is vitally important to support the chilli farmers to produce high quality sustainable food safe spices to compete in the international market. So, the agribusiness firms are focussing on clean spice to gain the profits from international market by providing service backward integration with farmers. In this service farmers are also getting profits through gaining more output. The study is taken with was focused on following objective "to study the impact of backward integration on input use pattern and profitability of chilli farmers.".

MATERIALS AND METHODS

Multistage random sampling design was adopted for selection of sample at different levels viz., for selection of district, mandals and villages in the present study. Two major Agribusiness firms, i.e., ITC and Synthite that are following backward integration in chilli farming in Prakasam district were purposively selected for the study. In Andhra Pradesh, Prakasam district was selected as the integrated chilli farmers of both ITC and Synthite are present in this district. Four mandals from of Prakasam district, viz., Naguluppala Padu, Tallur, Bestavaripeta and Recharla mandals were selected based on based on the maximum number of chilli farmers present. Naguluppala Padu and Tallur districts are selected based on maximum number of chilli farmers that are integrated with Synthite company. While in case of ITC, Bestavaripeta and Recharla mandals are having maximum number of integrated chilli farmers were selected. From each mandal two villages are selected. A total 8 villages are selected. From each village, 8 integrated farmers and 8 non-integrated farmers were selected. Total 128 farmers were selected for the study. The sample size was done by considering the population of farmers. The desired sample size was determined by using Cochran's (1963) formula below,

$$n = \frac{n_o}{1 + \frac{n_o - 1}{N}}$$

Where $n_0 = \frac{z^2 pq}{e^2}$

n = Sample size

N = Population size

z = Confidence level

p = Proportion of the population

$q = 1 - p$

e = Allowable error

If the population is finite then the sample size error will be reduced slightly. This is because a given sample size provides proportionately more information for a finite population than for an infinite population. In that case, Cochran (1963) recommends 'p' to take the value of 0.5 in which case 'n' will be maximum and the sample will yield at least the desired precision. Sample size of integrated chilli farmers in each village becomes 8.3 ~ 8 that is 8 villages selected for the study for equal allocation of sample in the villages.

Costs and Returns Calculation

The structure of the average costs and returns of the integrated farmers and non-integrated chilli farmers were calculated. The costs and returns are calculated for rupees per hectare.

Variable Cost = Value of human labour + Value of owned and hired machined power + Value of seeds purchased + Value of manures + Value of fertilizers + Value of plant protection chemicals + Irrigation + Interest on working capital

Fixed cost =Depreciation, Repairs and Maintenance+ Land Revenue, cess and taxes + Imputed rental value of owned land+ Interest on owned fixed capital etc.,

Total cost = Variable costs + Fixed costs

Gross returns = Yield * Price

Gross margin = Gross returns – Total variable costs

Decomposition Analysis

Chilli farming under backward integration system followed integrated management system for agricultural practices for better farming. In order to identify the effects of inputs impact on production of integrated and non-integrated chilli farmers, decomposition analysis was undertaken. It reveals the total productivity, profitability and input use pattern difference between integrated and non-integrated chillies cultivation system.

The output decomposition model developed by Bisaliah (1977) was used for investigating the contribution of various constituent sources to the input use pattern, productivity and profitability difference between the integrated and non-integrated farmers. For any two different production functions, the total change in the productivity can be brought out by shifts in the production parameters that defined the production functions itself and by the changes in the input-use levels. Therefore, the production function was considered as the convenient econometric model for decomposing the productivity difference.

$$\ln Y = \ln b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + ui \quad \ldots(1)$$

Where, Y = Gross returns (₹/ha),

X_1= Seed (₹/ha),

X_2= Human labour (₹/ha),

X_3 = Machine power (₹/ha),

X_4 = Manures (₹/ha),

X_5 = Fertilizers (₹/ha)

X_6 = Plant protection chemicals (₹/ha),

X_7 = Irrigation (₹/ha),

b_j = Regression coefficients ($j = 0,1,2\ldots,k$) ($k = 7$),

U_i = Error term, and

The output decomposition model used in this study was,

$$ln\ Y_1 = ln\ b_{01} + b_{11}\ lnX_{11} + b_{21}\ lnX_{21} + b_{31}\ lnX_{31} + b_{41}\ lnX_{41} + b_{51}\ lnX_{51} + b_{61}\ lnX_{61} + b_{71}\ lnX_{71} + u_{i1} \quad \ldots(2)$$

$$ln\ Y_2 = ln\ b_{02} + b_{12}\ lnX_{12} + b_{22}\ lnX_{22} + b_{32}\ lnX_{32} + b_{42}\ lnX_{42} + b_{52}\ lnX_{52} + b_{62}\ lnX_{62} + b_{72}\ lnX_{72} + u_{i2} \ldots(3)$$

Where, Y, X_1, X_2, X_3, X_4, X_5, X_6, $X_7 b_j$ and u_i are as denoted in Equation (1). However, Equations (2) and (3) represents integrated and non-integrated regression functions, respectively. The difference between the equations of integrated and non-integrated farms is as given in equation (4) below:

$$ln\ Y_1 - ln\ Y_2 = ln\ (Y_1/Y_2) = \{ln\ b_{01} - ln\ b_{02}\} + \{(b_{11} - b_{12})\ ln\ X_{12} + (b_{21} - b_{22})\ ln\ X_{22} + (b_{31} - b_{32})\ ln\ X_{32} + (b_{41} - b_{42})\ ln\ X_{42} + (b_{51} - b_{52})\ ln\ X_{52} + (b_{61} - b_{62})\ ln\ X_{62} + (b_{71} - b_{72})\ ln\ X_{72}\} + \{b_{11} ln(X_{11}/X_{12}) + b_{21} ln(X_{21}/X_{22}) + b_{31} ln(X_{31}/X_{32}) + b_{41} ln(X_{41}/X_{42}) + b_{51} ln(X_{51}/X_{52}) + b_{61} ln(X_{61}/X_{62}) + b_{71} ln(X_{71}/X_{72})\} + u_{i1} - u_{i2} \quad \ldots(4)$$

The decomposition Equation (4) gives an approximate measure of the percentage change in output in backward integration chilli farming system in the production process. The first flower bracketed expression on the right-hand side of equation (4) is the measure of percentage change in output due to shift in scale parameter of the production function. The second flower bracketed expression is the difference between output elasticities each weighted by natural logarithms of the volume of that input used under non-integrated farmer category, a measure of change in output is due to shift in the slope parameters of the production function. The third flower bracketed expression is the sum of the natural logarithms of the ratio of each input of integrated to non-integrated farmers, each weighted by the output elasticity of that input. This expression is a measure of change in the output due to change in per hectare quantities of inputs used in the production process.

RESULTS

The structure of the average costs and returns of the integrated farmers and non-integrated chilli farmers was presented in Table 1. The average gross margin of the integrated chilli farmers was ₹ 1,78,631.53,78,631.53 per ha while that of non-integrated chilli farmers was ₹ 1,14,060.14 per ha. This implies that the integrated chilli production was more profitable than non-integrated chilli production in the study area as the integrated chilli farmers are getting more per unit price than non-integrated farmers. Non-integrated chilli farmers were facing price uncertainty due to price fluctuations in the market price of chilli.

Table 1: Costs and returns of integrated and non-integrated chilli farmers (₹/ha)

Variables	Integrated farming (n=64)	Non-integrated farming (n=64)
Seed	20,258.13	16,459.82
Human labour	82,390.00	1,08,368.50
Machine power	23,009.53	20,827.42
Manures	13,755.44	9,289.53
Fertilizers	40,846.11	37,002.70
Plant protection chemicals	44,121.80	33,520.00
Irrigation	18,968.75	10,115.63
Miscellaneous expenses	5,637.20	3,531.60
Interest on working capital	5606.51	5364.66
Total variable costs (TVC)	3,04,593.47	2,91,479.86
Depreciation	360.41	290.38
Land revenue	500	500
Rental value of own land	43281.60	38471.95
Interest on fixed capital	3224.85	1987.07
Total fixed cost (TFC)	47,366.86	44,249.40
Total cost (TVC+TFC)	3,51,960.33	3,35,729.26
Yield (Qtl/ha)	51	45
Gross returns (GR)	4,64,865	4,05,540
Gross margin (GR-TVC)	1,78,631.53	1,14,060.14

The seed cost per hectare of integrated farmers was ₹ 20,258.13 while for non-integrated farmers it was, ₹ 16,459.82. Integrated farmers are purchasing chilli fruit then they dry it to obtain seed so, quantity purchased was high. Whereas non-integrated farmers are purchasing direct seeds. Human labour cost per hectare for integrated farmers was ₹ 82,390.00 while for non-integrated farmers it was ₹ 1,08,368. The difference is due to the use of more human labour for spraying pesticides and application of fertilizers by non-integrated farmers than integrated farmers. The cost of machine power, manures and irrigation for integrated farmers were ₹ 23,009.53, ₹ 13,755.44 and ₹ 18,968.75 respectively, and same for non-integrated farmers were ₹ 20,827.42, ₹ 9,289.53 and ₹ 10,115.63 respectively. The cost of fertilizers and plant protection chemicals for integrated farmers were ₹ 40,846.11 and ₹ 44,121.80. The cost of fertilizers and plant protection chemicals for non-integrated farmers was ₹ 37,002.70 and ₹ 33,520.

The cost difference between integrated farmers and non-integrated farmers for fertilizers and plant protection chemicals is due to the purchase of costly pesticides by integrated farmers than non-integrated chilli farmers. Fixed cost per hectare as estimated for integrated farmers was ₹ 47,367 and for non-integrated farmers was ₹ 44,249. The input cost components of integrated and non-integrated farmers were depicted in Fig. 1.

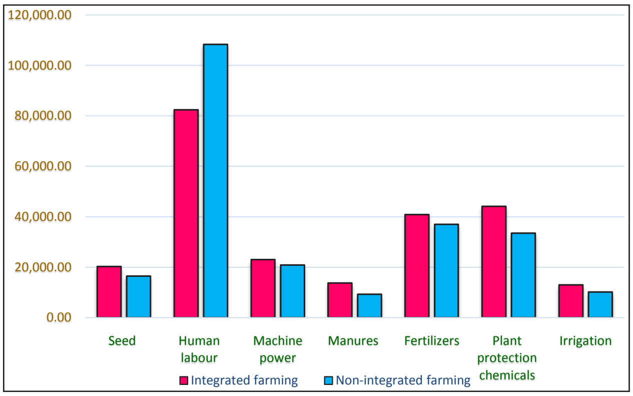

Fig.1: Input costs of integrated and non-integrated farmers

Decomposition analysis was used to estimate the contribution of various resources to the outcome difference between integrated and non-integrated farmers. The outcome difference resulted by adoption of backward integration technology between the integrated and non-integrated productions was decomposed into its constituent sources and results are presented in Table 2. The decomposition analysis showed that the per hectare returns of integrated farming was 13.28 per cent higher than that of non-integrated farming. The backward integration technology component was contributing 3.70 per cent to the total increase in output. This implies that with no further input application, chilli outcome could be increased by 3.70 per cent just by adopting the backward integration technology. Technical change affects the output by shifting either intercept or the slope coefficients, or both. Technical changes divided into neutral technical and non-neutral technical changes. This revealed a -940.03 per cent contribution in the scale parameter (i.e., Neutral technical change) and a 943.73 per cent contribution from the slope parameters (i.e., non-neutral technical change).

Table 2: Decomposition analysis

Sl. No.	Particulars	Percentage
	Total observed difference in output	**13.28**
1.	**Source of output growth**	
(a)	Neutral component	-940.03
(b)	Non-neutral component	943.73
	Total estimated difference in output due to technology	3.70
2.	**Input contribution**	
(a)	Seeds	1.37
(b)	Human labour	12.06
(c)	Machine power	0.17
(d)	Manures	-0.09
(e)	Fertilizers	-2.51
(f)	Plant protection chemicals	-0.96
(g)	Irrigation	0.46
	Total estimated difference in output due to input difference	9.58

The total contribution of changes in the levels of input use to the outcome differences between the two groups was 9.58 per cent. This implies that the outcome of the integrated farming could increase by 9.58 per cent if the input use leads to increase in the same level as that of the non-integrated farming. Backward integration with agribusiness firms providing certain inputs and technical guidence to the farmers, which makes the farmers to produce more productively than non- integrated farmers. .The major contributor amongst all the inputs to the difference in returns was the cost incurred by the farmers for using of human labour (12.06%) followed by seed (1.37%). Machine power and irrigation are found to be positively contributing but at a lower level i.e., 0.17 per cent and 0.46 per cent respectively. This implies that the integrated farmers gained a higher outcome by spending more on seed, human labour, machine power and irrigation than the non-integrated farmers. Manures, fertilizers and plant protection chemicals were found to reduce the gross returns. This means that the costs of manures, fertilizers and plant protection chemicals adopted by the non-integrated farmers increased output by 0.09 per cent, 2.51 per cent and 0.96 per cent respectively. Divya (2014) reported that per acre returns of chilli contract farmers were 55.14 per cent higher than non-contract farmers, the major contribution for higher income was human labour (8.20%), irrigation (1.59%) and manures (0.14%). Fertilizers (-2.20%) and plant protection chemicals (-1.80%) influencing negatively to the income of contract farmers. It could be suggested that usage of manures, fertilizers and plant protection chemicals on higher side leading to inefficiencies.

CONCLUSIONS

The decomposition analysis showed that the per hectare returns of integrated farming was 13.28 per cent higher than that of non-integrated farming. The integrated technology component was contributing 3.7 per cent to the total increase in output. The total contribution of changes in the levels of input use to the outcome differences between the two groups was 9.58 per cent. The major contributor amongst all the inputs to the difference in returns was the cost incurred by the farmers on human labour (12.05 per cent) followed by seed (1.36 per cent). Machine power and Irrigation found to be positively contributing but at a lower level i.e., 0.16 per cent and 0.45 per cent respectively. This implies that the integrated farmers gained a higher outcome by spending more on seed, human labour, machine power and irrigation than the non-integrated farmers. Manures, fertilizers and plant protection chemicals were found to reduce the gross returns. This means that the costs of manures, fertilizers and plant protection chemicals adopted by the non-integrated farmers increased output by 3.55 per cent.

The study revealed that farmers who are following backward integration are getting more outcome through technology and proper input usage. So, backward integration technology increases output and quality of the produce, so it should be expanded by an assured alternative agency (Government or co-operative) to increase quantity and value of export of chilli. Creating awareness on optimum use of inputs by Agricultural Department, can help the farmers in reducing the excess usage of fertilizers and plant protection chemicals.

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Constraints Faced in Adoption of Establishment Techniques of Wheat in Karnal and Kaithal Districts of Haryana

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ABSTRACT

The study was conducted in Karnal and Kaithal districts of Haryana in 2017-18. Total forty (40) farmers were selected randomly from Karnal and Kaithal districts of Haryana. The major constraint in the study area for conventional technique of Karnal were problem of weed infestation, less effective Weedicides, non adoption of seed treatment, non adoption of recommended doses of fertilizers and high cost of potashic fertilizers. Same problems were observed under conventional technique in Kaithal district with slight more in percentage. Major problems of zero tillage technique in Karnal district includes problem of poor effective Weedicides, weed infestation, problem of less germination, limited availability of zero tillage machine at the time of sowing, non adoption of seed treatment and high cost of potashic fertilizers. Same problem were noticed under zero tillage technique in Kaithal district with slightly more in percentage. Major problems of turbo happy seeder technique noted in Karnal district were the problem of less effective Weedicides, weed infestation, limited availability of zero tillage machine at the time of sowing, high cost of potashic fertilizers, non adoption of seed treatment and problem of poor germination. Identical problems were observed under turbo happy seeder technique in Kaithal district with slightly more percentage.

Highlights

- Weed infestation, less effective Weedicides, non-adoption of recommended doses of fertilizers, high cost of potashic fertilizers and limited availability of zero tillage machine at the time of sowing were found as the major constraints confronted in adoption of establishment techniques of wheat by the farmers in the study area.

Keywords: Infestation, weed, shortage, machine, problems

Wheat (*Triticum aestivum* L.) is a crop of universal importance. In World, total area under wheat cultivation was 225 million hectares and production 761.3 million tonnes in 2016. India ranks second position in wheat production all over the world with area 30.78 million hectares and production 98.51 million tonnes in year 2016 with a productivity of 3200 kg/ ha. Main wheat producing states in India are Uttar Pradesh, Madhya Pradesh, Punjab, Haryana and Rajasthan. Haryana was important wheat producing state in the country with area and production 2.55 million hectares and 11.54 million tonnes in 2016 respectively. The productivity of wheat in Haryana was 4514 kg/ha. (DAC&FW, 2016). There were few extension constraints like lack of adequate manpower with the state department of agriculture and input agencies. The farmers also mentioned lack of money to purchase new machines and inputs. Lack of appropriate loose straw management, high cost of tillage, lack of money to buy machines and inputs, inadequate extension facilities were the serious constraints perceived by the non adopters. The new challenges demand

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economical use of resource and conservation to satisfy the rising needs. Troubles with conservation have assumed importance in view of widespread resource degradation problems and the need to reduce production cost, increase profitability and make agriculture more competitive. To attain the target of sustainable agriculture, scientists are now more serious than ever before. Conservation Agriculture (CA) has been recognized as the immediate as well as long-term solution to achieve goals of sustaining productivity, economic natural resource based and growth of the Indian farme Rs. The term CA refers to the system of raising crops without tilling the soil while retaining crop residues on the soil surface. The key elements which characterize CA includes minimum soil disturbance by adopting no-tillage and least amount traffic for agricultural operations, leaving and managing the crop residues on the soil surface, and adopting spatial and temporal crop sequencing/crop rotations to derive maximum benefits from inputs and minimize adverse environmental impacts (Abrol and Sangar 2006).

MATERIALS AND METHODS

A list of all the important constraints affecting the production was prepared with help of wheat growers. Regarding constraints analysis, the response (various constraints as perceived by the farmers in production of wheat through conventional, zero tillage and turbo happy seeder techniques in wheat.) were recorded on three point continuum i.e. very serious, serious and some what serious and subsequently assigned a weight-age of 3, 2 and 1, respectively. The constraints score of each respondent as well as of all the respondents for each item pertaining to production constraints in conventional, zero tillage and turbo happy seeder techniques was worked out. The mean score and rank order were also computed.

Following formula was employed to calculate Mean Percent Score:

$$\text{Mean Score} = \frac{\text{Sum of score (constraint) for all responses}}{\text{Total number of respondents}}$$

Mean Percent Score =

$$\frac{\text{Mean of item (constraint) for all responses}}{\text{Maximum score of the item (constraint)}} \text{ X } 100$$

RESULTS AND DISCUSSION

Table 1: Production constraints in conventional technique (CT) in Karnal and Kaithal districts of Haryana (N = 40)

Sl. No.	Constraints / Problems	MS	MPS	Rank order
1	Weed infestation problem	2.1	70.00	1
2	Less effective Weedicides	1.5	50.00	2
3	Non adoption of seed treatment	0.9	30.00	3
4	Non adoption of recommended doses of fertilizers	0.55	18.33	4
5	High cost of potashic fertilizers	0.5	16.67	5

Table 2: Production constraints in zero tillage technique (ZTT) in Karnal and Kaithal districts of Haryana (N = 40)

Sl. No.	Constraints / Problems	MS	MPS	Rank order
1	Less effective Weedicides	1.50	50.00	1
2	Weed infestation problem	1.20	40.00	2
3	Problem of less germination	0.85	28.33	3
4	Limited availability of zero tillage machine at the time of sowing	0.60	20.00	4
5	Non adoption of seed treatment	0.60	20.00	4
6	High cost of potashic fertilizer	0.55	18.33	6

Table 3: Production constraints in turbo happy seeder technique (THST) in Karnal and Kaithal districts of Haryana (N = 40)

Sl. No.	Problems	MS	MPS	Rank order
1	Less effective Weedicides	1.00	33.33	1
2	Weed infestation problem	0.85	28.33	2
3	Limited availability of turbo happy seeder at the time of sowing	0.60	20.00	3
4	High cost of potashic fertilizers	0.55	18.33	4
5	Non adoption of seed treatment	0.45	15.00	5
6	Non adoption of recommended doses of fertilizer	0.45	15.00	5
7	Problem of less germination	0.45	15.00	5

The results of the study revealed that problem of weed infestation, less effective Weedicides, non adoption of seed treatment, non adoption of recommended doses of fertilizers and high cost of potashic fertilizers as major constraints which were inhibiting the production as well as profitability of conventional technique of wheat in both Karnal and Kaithal districts of Haryana. It was similar with the finding of (Bhatia and Dhaliwal, 2001), (Kumar *et al.* 2007) and (Ahmed and Sulaiman, 2011) in their respective studies. Similarly, in case of zero tillage technique (ZTT), problem of less effective Weedicides, weed infestation, poor germination, limited availability of zero tillage machine at the time of sowing, high cost of potashic fertilizers and non adoption of seed treatment were observed some of the major constraints those effecting the adoption as well as profitability of zero tillage technique in Karnal as well as Kaithal districts of Haryana. It was in conformity with the finding of (Dhaliwal and Singh, 2005), (Kumar *et al.* 2010) and (Tripathi *et al.* 2013) While, in case of turbo happy seeder technique (THST), problem of less effective Weedicides, weed infestation, limited availability of turbo happy seeder at the time of sowing, high cost of potashic fertilizers, non adoption of seed treatment, and problem of poor germination were observed some of the major constraints those effecting the adoption as well as profitability of turbo happy seeder technique in Karnal as well as Kaithal districts of Haryana. Although these constraints were found less in per-cent as compared to (ZTT) and (THST). It was similar with the finding of (Ramakrishna *et al.* 2005), (Singh and Dhaliwal, 2008), (Sidhu *et al.* 2015) and (Yogi *et al.* 2015) in their respective studies.

CONCLUSION

Weed infestation problem was found common in all the three establishment techniques of wheat. However the infestation was more in conventional technique as compare to zero tillage and turbo happy seeder technique. Seed treatment knowledge was found less in the farmers doing conventional tillage as compared to the farmers using zero and turbo happy seeder techniques. Problem of poor germination was found more in zero tillage technique as compared to turbo happy seeder and conventional technique. Availability of zero tillage and turbo happy seeder machines was found to be insufficient during the peak time of sowing. No technical constraints were viewed seriously by the farmers in the adopter category, however, there were few extension constraints like lack of adequate manpower with the state department of agriculture and input agencies. The farmers also mentioned lack of money to purchase new machines and inputs. Lack of appropriate loose straw management, high cost of tillage, lack of money to buy machines and inputs, inadequate extension facilities were the serious constraints perceived by the non adopters.

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Adoption of Improved Chickpea Production Technology in Haryana

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ABSTRACT

Chickpea is one of the important crop among pulses. It is important proteinaceous diet especially for vegetarian people. The total sample comprising of 120 chickpea growers as respondents from four villages in Tosham and Siwani block of Bhiwani district were selected. The data shows that majority of respondents used HC-3 variety (47 %) followed by C-235 (41.67 %) and HC-5 (33.33%). Maximum respondents (98 %) had high level of adoption followed by 68.00 per cent respondents had low level of adoption in seed rate. Majority of respondents (96.66 %) had high level of adoption followed by 95.00 per cent had medium level of adoption and 91.66 per cent had low level of adoption regarding field preparation. Maximum respondents (97 %) had high level of adoption followed by 92.33 per cent had medium level of adoption and 33.33 per cent had low level of adoption in case of sowing time. Most of the respondents (69.33 %) applied Di-ammonium phosphate as fertilizer followed by urea (66.66 %), single super phosphate (36%) and zinc sulphate (33.33 %), respectively. Majority of respondents (67.33 %) applied irrigation before flowering (45-60 days after sowing) followed by (33.33 %) respondents applied irrigation at pod formation stage and 33.33 per cent adopted seed treatment with Bavistin or *Trichodermma viridae* for wilt control. Similarly, 33.33 per cent respondents adopted cultural control of diseases (Ascochyta blight, Alternaria blight and Grey mold).

Highlights

- The main focus of study is to find out adoption of improved chickpea production technology.

Keywords: Adoption, chickpea, recommended cultivation, rhizobium, seed treatment

Chickpea (*Cicer arietinum* L.) is also known as gram which is one of the important pulse crop of our country. It is a protein-rich diet especially to the poor in developing countries, where people are vegetarians or cannot afford animal protein and helps in enhancing the soil quality for subsequent cereal crop cultivation. India is the largest producer of chickpea but still imports chickpea from other countries and ranked first in area and production of chickpea in the world, followed by Pakistan, Australia and Iran. The highest productivity of chickpea (6120 kg/ha) is observed in Isreal followed by Yemen, Canada and Egypt and it is second most important pulse growing country worldwide in terms of area under cultivation but ranks third in production. At world level, total area of pulses in 2016 was 54.23 million hectares. Production of pulses was 39.66 million tonnes with 731 kg/hectare yield. In 2016-17 production of total pulses in India was 29280 thousand hectares with 22950 thousand tonne productions (Anonymous, 2017).

Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, Chhattisgarh, Bihar and Jharkhand are major chickpea producing

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states contributing more than 95 per cent to the total chickpea production. Madhya Pradesh is the single largest producer in the country accounting for over 40 per cent of total production while Rajasthan, Maharashtra, Uttar pradesh and Andhra pradesh contribute about 14 per cent, 10 per cent, 9 per cent and 7 per cent, respectively.

It was observed that the productivity of chickpea was found low in comparison to their potential yield in existing area. It showed improvement in chickpea production was needed through conservation, diversification of agriculture and to enhance adoption level of improved chickpea production technology. So as to increase the productivity, particularly under rainfed chickpea growing regions was one of the major challenges and concern which need to be addressed on priority basis. A need has been felt to identify the gap in technology adoption in pulse crops so that appropriate measure can be taken to emphasize the adoption of improved technology, which will ultimately lead to increased productivity and production. Keeping these things in mind, the objectives of study was undertaken to know the personal profile of chickpea growers and to find out the adoption level of improved chickpea production technology.

METHODOLOGY

The study was conducted in Bhiwani district of Haryana. Two blocks Tosham and Siwani were selected from Bhiwani district. Two villages were randomly selected from each block. Thus, total number of four villages were selected, namely, Khanak and Kirawar from Tosham, and Gaindawas and Barwa from Siwani. From each village, 30 farmers were selected randomly. Thus, the total numbers of 120 farmers were interviewed. The data collected were tabulated and analyzed. The appropriate statistical tools i.e. percentage, total weighted score, mean score, rank order were used. Rank order was calculated by aggregate total score were calculated based on calculated score. A weighted mean score was obtained and the maximum weighted mean score so obtained were given the rank 1st and the next subsequent one was given 2nd and so on the descending orders.

Adoption is operationally defined as degree of actual use of improved cultivation practices by Gram growers. It was measured on three point continuum as fully adopted, partially adopted and somewhat adopted by assigning the score of 3, 2 and 1, respectively. The adoption score was then converted into adoption index by applying following formula:

Adoption index =

$$\frac{\text{Obtained adoption score}}{\text{Maximum Obtainable adoption score}} \times 100$$

Later on respondents were categorized as fully adopted, partially adopted and somewhat adopted, respectively.

RESULTS AND DISCUSSION

The collected information was analyzed for ascertaining level of adoption of recommended technology in chickpea cultivation.

The data reported in table 1 reveals that the majority of respondents (39.16 per cent) were matriculate, followed by 25.83 percent, 14.16 per cent, 10.83 per cent. 5.83 per cent, and 4.16 per cent and 0.00 per cent was having education middle school, higher secondary, primary, graduate, illiterate and post-graduate. It was also observed that two third of respondents (63.33 per cent) were living in nuclear family system and the remaining (36.66 per cent) respondents were living in joint family system in the area of investigation. It has been also depicted that respondents It is apparent from table 1 that 70 per cent respondents were engaged in farming and only 50 per cent of the farmers had job or other business along with farming.

Table 1: Profile of chickpea growers (N = 120)

Sl. No.	Variable (s)	Category	Number	Percentage
1	Age	Young (20-35 years)	29	24.16
		Middle(36-50 years)	49	40.83
		Old (above 50 years)	42	35.00
2	Education	Illiterate	05	04.16
		Primary	13	10.83
		Middle	31	25.83
		Metric	47	39.16
		Higher secondary	17	14.16
		Graduate	07	05.83
		Post graduate	00	0.00

3	Caste	General	26	21.66
		OBC	64	53.33
		SC	30	25.00
4	Family type	Nuclear	76	63.33
		Joint	44	36.66
5	Family size	Small (up to 4 members)	40	33.00
		Medium (5 to 6 members)	52	43.33
		Large (7 members and above)	28	23.33
6	Occupation	Only farming	70	58.33
		Business/Job and farming	50	41.66
7	Land holding	Landless	00	00.00
		Less than 1 acre	09	07.50
		Above 1 and up to 5 acres	50	41.66
		Above 5 and up to 10 acres	29	24.16
		Above 10 to 15 acres	14	11.66
		Above 15 acres	18	15.00

Status of gram growers of the study area

Farm implements

The data presented in table 2, reveals that 100 per cent respondents owned plough, wooden planker, spade and hand hoe whereas 66.60 per cent owned tractor, 62.50 per cent sprayer, 60.83 per cent harrow, 58.33 per cent cultivator, 2.50 per cent seed cum fertilizer drill for using in the agricultural activities.

Table 2: Farm implements available with farmers (N = 120*)

Sl. No.	Farm implements	Frequency	Percentage
1	Tractor	80	66.60
2	Harrow	73	60.83
3	Cultivator	70	58.33
4	Seed cum fertilizer drill	03	02.50
5	Laser land leveler	00	00.00
6	Combined machine	00	00.00
7	Puddler	00	00.00
8	Rotavator	00	00.00
9	Plough	120	100.00
10	Wooden planker	120	100.00
11	Spade	120	100.00
12	Hand hoe	120	100.00
13	Sprayer	75	62.50

** Multiple responses.*

Cropping system

The data presented in table 4 reveals that 83.33 per cent respondents had double cropping system followed by 15.00 per cent respondents have monocropping and 1.66 per cent respondents had adopted intercropping.

Table 4: Cropping system (N = 120)

Sl. No.	Cropping system	Frequency	Percentage
1	Monocropping	18	15.00
2	Intercropping	02	01.66
3	Double cropping	100	83.33
	Total	**120**	**100**

Crop rotation

The data mentioned in table 5 indicated that majority of the respondents (85.83 per cent) were growing pearl millet in *Kharif* season and chickpea in *Rabi* season followed by 08.33 per cent respondents were growing cotton in *Kharif* season and chickpea in *Rabi* season and 05.83 per cent respondents were growing sorghum in *Kharif* season and chickpea in *Rabi* season.

Table 5: Crop rotation (N = 120)

Sl. No.	*Kharif*	*Rabi*	Frequency	Percentage
1	Pearl millet	Chick pea	103	85.83
2	Maize	Chick pea	00	00.00
3	Sorghum	Chick pea	07	05.83
4	Cotton	Chick pea	10	08.33
	Total		**120**	**100**

Irrigation facilities

The sources of irrigation and assured irrigation are one of the most important factors for agriculture. It can be observed that farmers were having tube wells; canal and submersible pump for irrigation, which is, own and hired.

Table 6: Irrigation facilities (N=120)

Sl. No.	Modes of irrigation	Frequency	Percentage
1	Submersible pump	06	05.00
2	Tube Well (own)	18	15.00
3	Tube Well (hire basis)	52	43.33
4	Canal	44	36.66
	Total	**120**	**100.00**

It is clear from table 6 revealed that 15.00 per cent respondents are using tube well which is owned and 43.33 per cent hired as irrigation sources followed by 36.66 per cent respondents used canal water for irrigation and 5.00 per cent respondents used submersible pump as irrigation source.

Mass media exposure

The data in table 7 revealed that reading of newspaper ranked first with mean score of 2.85, followed by TV and radio ranked second and third with weighted mean score of 2.83 and 2.10, respectively. Kisan Seva Kendra was ranked fourth with weighted mean score of 1.43, magazine was ranked fifth with weighted mean score of 0.85 and internet was ranked last with 0.43 as weighted mean score, whereas only 45.83 per cent of farmers obtained training.

Extension contact

This section comprises of contact of farmers with various extension officials and the frequency of their contact. Various extension officials with whom the farmers had contacts are enlisted in the table 8 with the frequency of their contacts.

The data depicted in table 8 revealed that among the extension contact of farmers, the most popular were the progressive farmers with weighted mean score 3.80. Scientists and ADO ranked second and third among extension officials with weighted mean score 2.85 and 2.30, followed by SDAO/SMS and NGO as fourth and fifth with weighted mean score 1.98 and 0.26, respectively.

It is evident from the table 9 regarding varieties, HC-3 had high level of adoption (47 per cent) followed by C-235 had medium level of adoption (41.67 per cent) and HC-5 had low level of adoption (33.33 per cent).

In case of seed rate, 98.00 per cent respondents had high level of adoption followed by 68.00 per cent respondents had low level of adoption.

With regard to seed treatment/ use of Rhizobium culture were found that majority of respondents had 33.30 per cent level of adoption at the time of investigation.

Table 7: Mass media exposure (N=120)

Sl. No.	Mass media	Used	Extent of utilization: Daily (3)	Often (2)	Sometimes (1)	Total score	Weighted mean score	Rank
1	Newspaper	118(98.33)	109(327)	07(14)	02(2)	343	02.85	I
2	TV	116(96.67)	110(330)	04(8)	02(2)	340	02.83	II
3	Radio	94(78.33)	70(210)	19(38)	05(5)	253	02.10	III
4	Kisan Seva Kendra	100(83.33)	03(9)	66(132)	31(31)	172	01.43	IV
5	Magazine	55(45.83)	12(36)	23(46)	20(20)	102	00.85	V
6	Internet	21(17.5)	13(39)	05(10)	03(3)	52	00.43	VI
7	Workshop/Training	55(45.83)	-	-	-	-	-	-

(Figures in parentheses in column 3 indicate percentages; columns 8 indicate weighted mean scores and column 9 indicates ranks).

Table 8: Extension contact (N=120)

Sl. No.	Extension Official	Frequency of contact: Weekly (4)	Fortnightly (3)	Monthly (2)	Whenever Needed (1)	None (0)	Total score	Weighted mean score	Rank
1	Progressive farmer	110(440)	4(12)	1(2)	3(3)	2(0)	457	03.80	I
2	Scientists	64(256)	14(42)	10(20)	24(24)	8(0)	342	02.85	II
3	ADO	44(176)	8(24)	13(26)	51(51)	4(0)	277	02.30	III
4	SDAO/SMS	30(120)	13(39)	9(18)	60(60)	8(0)	237	01.98	IV
5	NGO	5(20)	1(3)	3(6)	2(2)	109(0)	31	00.26	V

(Figures in parentheses indicates percentage; columns 5 indicates weighted mean scores and column 6 indicates ranks)

Table 9: Adoption of recommended chickpea production practices

Sl. No.	Recommended varieties	Fully Adopted (3)	Partially Adopted (2)	Somewhat adopted (1)	Total mean score	Weighted mean score	Percentage	Rank order
	Varieties							
	For Desi Chickpea							
1	C-235	5(15)	20(40)	95(95)	150	1.25	41.67	II
2	HC-1	11(33)	49(98)	60(60)	191	1.59	38.66	IV
3	HC-3	0(0)	50(100)	70(70)	170	1.41	47.00	I
4	HC-5	0(0)	0(0)	120(120)	120	1.00	33.33	VI
	For Kabuli Chickpea							
5	HK-1	5(15)	10(20)	105(105)	140	1.16	38.00	V
6	HK-2	5(15)	15(30)	100(100)	145	1.20	40.00	III
	Seed rate							
1	Desi Chickpea (15-18 kg/acre)	113(339)	7(14)	0(0)	353	2.94	98.00	I
2	Kabuli Chickpea (36kg/acre)	10(30)	5(10)	105(105)	245	2.04	68.00	II
	Seed treatment							
1	Treatment with *Rhizobium* culture	0(0)	0 (0)	120(120)	120	1	33.33	I
	Preparatory tillage							
1	Number of ploughing done during last year	112(336)	8(16)	0(0)	342	2.85	95.00	I
2	Name the plough used for ploughing	109(327)	11(22)	0(0)	369	3.07	96.66	II
3	Number of the planking done after ploughing	90(270)	30(60)	0(0)	330	2.75	91.66	III
	Sowing time							
1	Around mid October (Desi chickpea)	112(336)	6(12)	2(2)	350	2.91	97.00	I
2	Around last week of October (Kabuli chickpea)	95(285)	23(46)	2(2)	333	2.77	92.33	II
3	2nd week of November to 3rd week of Nov (For irrigated conditions)	0(0)	0(0)	120(120)	120	1.00	33.33	III
	Sowing Method							
1	Method of sowing (Line sowing, Seed drill and Pora method)	43(129)	67(134)		273	2.27	75.66	I
2	Spacing at yours farm(R×R=45cm)	33(99)	70(140)		256	2.13	71.00	II
	Manures and fertilizers							
1	Urea (12kg/ac)	32(96)	56(112)	32(32)	240	2.00	66.66	II
2	SSP (100kg/ac)	0(0)	10(20)	110(110)	130	1.08	36.00	III
3	DAP (35kg/ac)	21(63)	88(176)	11(11)	250	2.08	69.33	I
4	$ZnSo_4$ (10kg/ac)	0(0)	0(0)	120(120)	120	1.00	33.33	IV
	Irrigation Requirement							
1	Before flowering	5(15)	113(226)	2(2)	243	2.02	67.33	I
2	Pod formation stage	0(0)	0(0)	120(120)	120	1.00	33.33	II

	Weed control							
1	25-30DAS	116(348)	4(8)	0(0)	356	2.96	98.66	I
2	45-50DAS	23(69)	50(100)	4(4)	173	1.44	48.00	II
	Disease control							
1	Wilt (Seed treatment with *Trichodermma viridae* 4g/kg plus vitavax 1g/kg in 5ml of water)	0(0)	0(0)	120 (120)	120	1	33.33	I
	Cultural control							
1	Ascochyta blight Grow resistant/tolerant varieties-HC-1 and C-235 or burn infected plant parts	0(0)	0(0)	120(120)	120	1	33.33	I
2	Alternaria blight	0(0)	0(0)	120(120)	120	1	33.33	I
3	Grey mold	0(0)	0(0)	120(120)	120	1	33.33	I
	Chemical insect pest control							
1	Gram pod borer (400ml Quinolphos 25 EC or 400g carbaryl 50 WP or 200 ml mono-crotophos 36SL in 100 litre of water)	0(0)	95(190)	25(25)	215	1.79	59.66	I
2	Gram dhora (Use 7.5 ml mustard oil or groundnut oil or mix mustard or groundnut oil with 1.75ml turmeric/kg seed)	0(0)	0(0)	120(120)	120	1	33.33	II

It was observed in preparatory tillage that 96.66 per cent respondents had high level of adoption followed by 95.00 per cent had medium level of adoption and 91.66 per cent had low level of adoption. Regarding sowing time 97.00 per cent respondents had high level of adoption followed by 92.33 per cent had medium level of adoption and 33.33 per cent had low level of adoption. In case of sowing method, 75.66 per cent respondent had high level of adoption followed by 71.00 per cent had low level of adoption. Regarding manures and fertilizers, 69.33 per cent respondents applied Di-ammonium phosphate as fertilizer followed by 66.66 per cent urea, 36.00 per cent single super phosphate and 33.33 per cent zinc sulphate. With regard to irrigation requirement, it was cleared that 67.33 per cent respondents applied irrigation before flowering (45-60 days after sowing) followed by 33.33 per cent respondents applied irrigation at pod formation stage. It was observed in weed control that 98.66 per cent respondents done weeding at 25-30 days after sowing followed by 48 per cent respondents done weeding at 45-50 days after sowing. In case of chemical disease control, 33.33 per cent respondents had adopted chemical control of wilt. Regarding cultural control, 33.33 per cent respondents had adopted cultural control of diseases (Ascochyta blight, Alternaria blight and Grey mould). In case of chemical insect- pest control, 59.66 per cent respondents had adopted control measure of gram pod borer followed by 33.33 per cent respondents had adopted control measure of gram dhora. It was observed in weed control that 98.66 per cent respondents done weeding at 25-30 days after sowing followed by 48 per cent respondents done weeding at 45-50 days after sowing. In case of chemical disease control, 33.33 per cent respondents had adopted chemical control of wilt. Regarding cultural control, 33.33 per cent respondents had adopted cultural control of diseases (Ascochyta blight, Alternaria blight and Grey mould). In case of chemical insect- pest control, 59.66 per cent respondents had adopted control measure of gram pod borer followed by 33.33 per cent respondents had adopted control measure of gram dhora.

CONCLUSION

The maximum adoption level was reported in adoption of exact seed rate, preparatory tillage, sowing time and weed control. This was followed by practice like 'method of sowing', 'application of manures and fertilizers', 'irrigation requirement', 'chemical insect-pest control' and 'adoption of improved varieties of chickpea'. While practice like 'seed treatment', 'cultural control', 'chemical disease control' were having less adoption level by the respondents.

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Economic Analysis of Pea (*Pisum sativum*) in Himachal Pradesh

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ABSTRACT

The study was conducted in Solan district of Himachal Pradesh to analyze the economics of pea cultivation at different farm size category. The study reveals that total cost of cultivation of pea production was ₹ 84699.37 per hectare. Out of which cost A1, A2, B1, B2, C1, C2, and C3 were ₹ 44150.67, ₹ 44150.67, ₹ 45135.52, ₹ 57521.56, ₹ 64613.39, ₹ 76999.43 and ₹ 84699.37 respectively. The cost of cultivation of pea in case of marginal farms was higher as compared to different farm size category. The total yield of pea production was 72.16 quintals per hectare. The total returns and net returns from pea production were ₹ 144324.32 and ₹ 59624.95 per hectare, respectively. The total returns and net returns from pea in case of large farms were higher as compared to different farm size category.

Highlights

- The cost of cultivation of pea in case of marginal farms was higher as compared to different farm size category whereas total returns and net returns from pea in case of large farms were higher as compared to different farm size category.

Keywords: Pea, Cost of cultivation and Returns, Himachal Pradesh

The potential of vegetables in contributing to the national economy has been well recognized in recent years. India ranks second in the area as well as production of pea next to China. In spite of that, this seemingly high level of production can provide only 208 grams of vegetables per capita (Sharma, 2003), as against the suggested dietary intake of 275g and 250 g per capita per day for adult male and female, respectively for undertaking moderate work (Swaminathan, 2002). The total area, production and productivity of pea in India in 2017-18 was 540.48 thousand Ha, 5422.14 thousand MT and 10.0 MT/ha respectively (Anonymous, 2018). The major pea growing states are Uttar Pradesh, Madhya Pradesh, Jharkhand, Punjab, Himachal Pradesh, West Bengal, Haryana, Bihar, Uttarakhand, Orissa and Karnataka. Himachal Pradesh is 5th leading pea producing state of India with total production of 294.96 thousand metric tonnes during the year 2017-18 (Anonymous, 2018).

Pea is small spherical seed or pod of fruit *Pisum sativum* and belongs to leguminaceae family along with beans and peanuts. It was one of the first plants cultivated by humans and remains an important food crop today. The pea is native to western Asia and North Africa. Wild peas can still be found in Afghanistan, Iran, and Ethiopia (Oelke 1991).

Peas, like many legumes, contain symbiotic bacteria called *Rhizobia* within root nodules of their root systems. These bacteria have the special ability of fixing nitrogen from atmospheric, molecular nitrogen (N_2) into ammonia (NH_3). It contains high

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percentage of digestible proteins, vit-A and vit-C, rich in minerals like Ca and P.

Peas cultivation is highly labour-intensive like all other vegetable crops and requires high dosages of manures and fertilizers (Rao and Tripathi 1979; Khunt and Desai 1996). The main constituent of the cost of cultivation of peas is manures and fertilizers, followed by cost on bullock/ human labour/tractor and pesticides/chemicals. Thakur *et al.* (1994) observed that the income per hectare from vegetable crops has been almost four-times, as compared to that from food crops .Thus, the farmers should have to be motivated to diversify to more remunerative cropping patterns like vegetable cultivation instead of the traditional, less profitable ones (Singh 1995). Similar types of results were reported by (Sharma *et al.* 2000; Maurya *et al.* 2001).

The objective of my study was to study the cost of cultivation of this most important cash crop among vegetables.

MATERIALS AND METHODS

The study was conducted in Solan district of Himachal Pradesh. This area was selected because of its significant contribution with respect to area and production of vegetable crops in the state and simultaneously providing fruitful employment to the families involved in vegetable cultivation.

Multistage random sampling was adopted to select the ultimate sample of the respondents i.e. the vegetable growers.

(a) At the first stage, 2 blocks i.e. Kandaghat and Solan out of 5 blocks were selected.

(b) At the second stage, a list of villages growing vegetables in the selected blocks were prepared and 5 villages from each block were randomly selected.

(c) At the third stage, list of vegetable growers of the selected villages was prepared and a sample of 10 vegetable growers in each selected village were selected for collection of primary data. Thus the total sample consisted of 100 respondents.

A pre-tested structured interview schedule was prepared. Data was collected by personal interview method. For the analysis of data the total vegetable growers were divided into four classes according to the size of their land holdings, viz., marginal (<1 ha), small (1-2 ha), medium (2-4 ha) and large farmers (>4 ha).

Analytical Tools

Cost of cultivation

The cost of cultivation of vegetables crops was worked out by using various cost concepts defined below:

Cost A_1: It includes:

(a) Cost of hired human labour
(b) Cost of owned machinery
(c) Cost of hired machinery
(d) Cost of fertilizer
(e) Cost of manure
(f) Cost of seed (owned / purchased)
(g) Cost of plant protection chemicals
(h) Land revenue
(i) Depreciation of farm machinery, equipments and farm buildings
(j) Interest on owned working capital

Cost A_2 : Cost A_1 + Rent paid for leased in land
Cost B_1 : Cost A_1 + Interest on owned fixed capital assets excluding land
Cost B_2 : Cost B_1 + Rental value of own land (net of land revenue) + Rent paid for leased in land
Cost C_1 : Cost B_1 + Imputed value of family labour
Cost C_2 : Cost B_2 + Imputed value of family labour
Cost C_3 : Cost C_2 +10 percent of cost C_2 on account of managerial function performed by the farmer.

Income measures

For working out profitability of vegetable cultivation in the study areas following income measures were worked out:

(a) Family labour income (FLI)
It is the return to family labour (including management).
F.L.I. = Gross income – Cost B_2

(b) Net income (NI)
It is the net profit after deducting all cost items *i.e., variable and fixed costs from gross income.*
NI = Gross income – Total cost (Cost C_3)

(c) Farm business income (FBI)

It is the disposal income out of the enterprise and is defined as:

FBI = Gross income – Cost A_1 (cost A_2 in case of tenant operated land)

(d) Farm Investment Income (FII)

FII = Farm Business Income – Family Labour wages

Definitions of terms and cost concepts used:

- **Fixed cost:** The various items viz., land rent, land revenue, depreciation and interest on equipment investment, interest on owned fixed cost, which were used in the vegetable cultivation.
- **Variable cost:** Variable cost includes the expenditure on labour and material input cost and interest on working capital.
- **Inputs and costs:** Following were the various inputs used in the vegetable cultivation.
- **Hired human labour cost:** Hired human labour was estimated in terms of man days where in 8 hours of work in a day was considered as one man day. The man days were valued at ₹ 300 per man day.
- **Planting material cost:** The planting material cost was worked out at prevailing market price in the study area.
- **Fertilizer cost:** The fertilizers cost was calculated at the actual price paid by farmers.
- **Plant protection cost:** This variable included the expenses incurred on the purchase of insecticides, fungicides, weedicides etc. used for the various vegetable crops.
- **Depreciation:** The amount of depreciation for implements was calculated by the straight line method i.e., by dividing the original cost less junk value of implement by its expected life. This was apportioned to individual crop proportion to the total cultivated area.
- **Land revenue:** Actually paid land revenue by the farmers was taken into the study.
- **Land rent:** Land rent was evaluated at the rate of one fourth of the total produce produced and then converted into monetary units by multiplying it with prevailing farm harvest price.
- **Interest on working capital:** Interest on fixed and working capital is charged at the rate of 9 per cent per annum for half of the year.
- **Interest on fixed capital:** Interest on fixed and working capital has been charged at the rate of 9 per cent per annum on the average investment (half of the initial cost).
- **Family labour:** Family labour cost was calculated on the basis of charges paid to hired labour.
- **Gross return:** Gross return refers to the total income of the farmers earned from crop and livestock sources.
- **Net returns:** Return obtained by subtracting the total cost from gross return.

RESULTS AND DISCUSSION

Economics of Pea Production

Cost of production

Farm category wise cost of pea crop was estimated and results have been presented in Table 1. The overall cost of cultivation of pea was estimated to be ₹ 84699.37 per hectare. The cost of cultivation of pea in case of marginal farms was higher (₹ 94443.52) as compared to large farms (₹ 68004.39). It was ₹ 73632.04 on medium farms and ₹ 79941.99 on small farms.

Among different input operation on overall level, the per hectare cost was observed highest for FYM (₹ 8988.42) and the cost of owed human labour is the major contributor to the cost of cultivation of pea. The cost A1 in case of large farms was highest (53.26 %) as compared to marginal farms (51.76 %), medium farms (52.05 %) and small farms (52.60 %). There is no cost A2 because farmers used their owed land for cultivation of capsicum. Similar trend was found in cost B1 and cost B2 as in cost A1.The cost C1 in case of marginal farms was found highest (81.30 %) as compared to large farms (78.72 %), medium farms (79.80 %), and small farms (80.47%). The cost C3 in case of marginal farms was higher (₹ 128959.10) as compared to large farms (₹ 101657.19), medium farms (₹ 111533.48) and small farms (₹ 118695.63).

Table 1: Farm Category wise Cost of Pea under in Sampled Vegetable Growers (₹/ha)

Sl. No.	Particulars	Marginal	Small	Medium	Large	Overall
1	**Cost A1**					
	Human hired labour	6200.00	7538.46	7916.67	8808.14	7679.54
	Owned machinery labour	133.33	1461.54	972.22	1308.14	978.76
	Hired machinery labour	3000.00	341.88	694.44	872.09	1196.91
	Seed/plants	6275.83	5957.26	5666.67	5337.21	5792.47
	FYM	16100.00	7589.74	6750.00	6279.07	8988.42
	Fertilizer	3726.13	3341.95	3044.17	2932.15	3243.18
	Plant protection	5000.00	4991.45	5000.00	5000.00	5003.86
	Staking	1500.00	1497.44	1500.00	1500.00	1501.16
	Packaging	319.33	317.26	305.56	297.67	309.65
	Depreciation	6094.11	8593.01	6070.43	3477.85	5580.56
	Land Revenue	6.00	6.00	6.00	6.00	6.00
	Interest on working capital	528.18	412.96	398.12	404.18	433.67
	Sub-total	48882.93 (51.76)	42048.97 (52.60)	38324.27 (52.05)	36222.50 (53.26)	44150.67 (52.13)
2	**Cost A2**					
	Cost A1	48882.93	42048.97	38324.27	36222.50	44150.67
	Rental value of leased -in land	0.00	0.00	0.00	0.00	0.00
	Sub-total	48882.93 (51.76)	42048.97 (52.60)	38324.27 (52.05)	36222.50 (53.26)	44150.67 (52.13)
3	**Cost B1**					
	Cost A1	48882.93	42048.97	38324.27	36222.50	44150.67
	Interest on Fixed capital	838.78	1419.02	977.91	568.28	937.63
	Sub-total	49721.71 (52.65)	43467.99 (54.37)	39302.18 (53.38)	36790.79 (54.10)	45135.52 (53.29)
4	**Cost B2**					
	Cost B1	49721.71	43467.99	39302.18	36790.79	45135.52
	Rental value of land	12386.03	12386.03	12386.03	12386.03	12386.03
	Rental value of leased -in land	0.00	0.00	0.00	0.00	0.00
	Sub-total	62107.74 (65.76)	55854.02 (69.87)	51688.22 (70.20)	49176.82 (72.31)	57521.56 (67.91)
5	**Cost C1**					
	Cost B1	49721.71	43467.99	39302.18	36790.79	45135.52
	Imputed value of family labour	23750.00	16820.51	15250.00	12645.35	16899.61
	Sub-total	73471.71 (77.79)	60288.50 (75.42)	54552.18 (74.09)	49436.13 (72.70)	64613.39 (76.29)
6	**Cost C2**					
	Cost B2	62107.74	55854.02	51688.22	49176.82	57521.56
	Imputed value of family labour	23750.00	16820.51	15250.00	12645.35	16899.61
	Sub-total	**85857.74** (90.91)	**72674.53** (90.91)	**66938.22** (90.91)	**61822.17** (90.91)	**76999.43** (90.91)
7	**Cost C3**					
	Cost C2	85857.74	72674.53	66938.22	61822.17	76999.43
	Value of management input(10% of cost C2)	8585.77	7267.45	6693.82	6182.22	7699.94
	Sub-total	94443.52 (100.00)	79941.99 (100.00)	73632.04 (100.00)	68004.39 (100.00)	84699.37 (100.00)

Returns from pea under open field conditions

The information regarding the returns from pea per hectare basis is given in the table 2. The results revealed that on an overall basis, yield of pea was 72.16 quintals per hectare. The yield of pea was highest (79.83 qtls.) on marginal farms followed by medium farms. farms (76.39 qtls.), large farms (74.42 qtls.) and small farms (56.07 qtls.) which indicated that gross return were found higher in marginal farms as compared to small, medium and large farms. It may due to better management practices and efficient use of resources by marginal farmers.

Table 2: Farm Category wise Return from Pea in Sampled Vegetable Growers (₹/ha.)

Sl. No.	Particulars	Marginal	Small	Medium	Large	Overall
1	Yield of Pea (q)	79.83	56.07	76.39	74.42	72.16
2	Gross Return	159666.67	112136.75	152777.78	148837.21	144324.32
3	Farm Business Income (Gross return- Cost A1)	110783.74	70087.79	114453.51	112614.71	100173.66
4	**Family Labour income** (Gross return - Cost B2)	97558.92	56282.73	101089.56	99660.39	86802.77
5	**Farm Income (net income)** (Gross return - Cost C3)	65223.15	32194.76	79145.74	80832.82	59624.95
6	**Farm Investment Income** (Farm Business Income - Family Labour wages)	87033.74	53267.27	99203.51	99969.36	83274.04

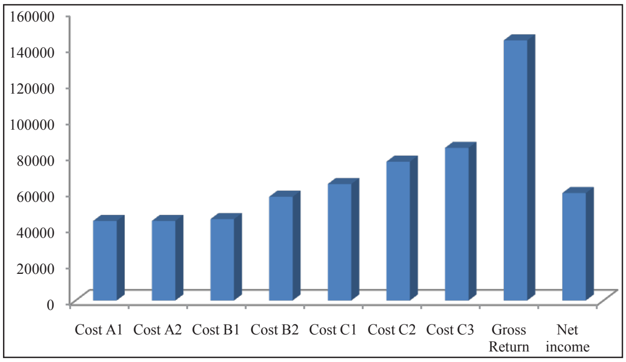

Fig. 1: Economics of Pea crop per ha in Himachal Pradesh

CONCLUSIONS

The total cost of cultivation was found ₹ 84699.37 per hectare in pea cultivation. The Cost A1 of pea recorded ₹ 44150.67 per hectare which contributes 52.13 % of the cost C3. The yield of green peas has been higher on marginal farms than medium and large farms because of better management in small farms. The gross and net returns have been found higher in large farms due to realization of higher prices because of cultivating early-maturing varieties and exploring other markets due to higher marketable surpluses. This crop, being highly labour-intensive, will help provide employment to the family members on the farm itself, particularly in the case of small and marginal farmers. It will provide impetus to the diversification programme of the state government, besides improving the soil health, being a leguminous crop. Improved variety seeds are of higher unit price and provide high productivity and return, therefore, to be used as per capacity of the growers. Bank credit and financial assistance should be available to the individual farmers for increasing the production. Training of farmers in the areas of production technology, grading, standardization of produce, quality control and modern method of marketing will prove to be a viable move. The government should establish adequate storages at village level for the purpose of orderly marketing of green pea to benefit both consumers and producers.

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An Economic Analysis of Redgram Seed Production in Chikkaballapura District of Karnataka, India

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ABSTRACT

The present study is based on primary data collected from 30 each of redgram seed producing farmers of BRG-1 variety and BRG-2 varieties taken up by KSSC, in Chikkaballapura district of Karnataka, during the agricultural year 2016-2017. The per hectare cost of cultivation (₹ 58,989), gross return (₹ 92,935), and net return (₹ 33,946) with yield of 15.4 quintals in BRG-1 variety seed production was higher than BRG-2 variety in which the cost of cultivation, gross returns and net returns were ₹ 51,768, ₹ 80,890 and ₹ 29,122, respectively, with a yield of 13.7 quintals . Hence, production of BRG-1 variety certified seed has resulted in a win-win situation for the farmers with higher yield and increased returns. The decision of the farmer on adoption of seed production technology was positively influenced by factors like assured market, seed subsidy, and technical guidance. The constraints faced by farmers in seed production were non-availability of labour, lack of pure and quality seeds. Higher yield and profitability associated with seed production can be effectively popularized among farmers, resulting in increased certified seed production to meet the demand.

Highlights

- Main problems in redgram seed production were non-availability of labour and lack of pure and quality seeds, being assured market as a main reason to take upon the seed production. BRG-1 varietal seed production is more profitable than BRG-2 variety.

Keywords: Seed production, BRG-2 variety, certified seed production

Redgram (*Cajanus cajan* L.) is one of the protein rich pulse crops in India which is also called as Pigeon pea or *Arhar* or *Tur*. According to FAO statistics, the total area under redgram is 6.9 million hectares producing 5.9 million tonnes in the year 2018, Asia contributing the most (3.2 million tonnes) followed by Africa (0.49 million tonnes) and America (0.074 million tonnes). India being the major producer contributing around 71.6 percent followed by Myanmar. In India, Redgram takes the second position in total pulse production with 4.25 million tonnes of production in an area of 4.43 million hectares in the year 2017-18 at a productivity level of 960 kg/ha. Among the states Maharashtra is the major producer with 1.07 million tonnes of production followed by Madhya Pradesh (0.84 million tonnes) and Karnataka (0.77 million tonnes) (B. Rajendrer *et al.* 2018). Nutritionally, 100 g of redgram contains 22.40 g of protein, 48.19 g of carbohydrates 2.74 g of fat and around 1.39 mg of Calcium 2.3 mg of Zinc (Taalari *et al.* 2018). Northern parts of Karnataka accounts nearly 90 percent of total red gram area in the state. During 2010-11 the red gram was grown over 8.91 lakh hectares with a production of 5.29 lakh tonnes and a productivity of 625 kg/ha (Suresh K. *et al.* 2016). Redgram is used as both the food crop (dried peas, flour, or green vegetable peas) and forage/

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cover crop. In combination with cereals, pigeon peas make a well-balanced meal and hence are favoured by nutritionists as an essential ingredient for balanced diets. The dried peas may be sprouted briefly, then cooked, for a flavour different from the green or dried peas. Sprouting also enhances the digestibility of dried pigeon peas via the reduction of indigestible sugars that would otherwise remain in the cooked dried peas.

MATERIALS AND METHODS

The study is carried out in Gowribidnur and Bagepalli taluks of Chikkaballapura district on BRG-1 and BRG-2 varietal seed production of redgram, as these taluks are one among the major seed producing taluks, as per the list given by Karnataka State Seeds Corporation Limited. Thirty farmers cultivating each variety viz; BRG-1 and BRG-2 varieties were selected randomly in the study area.

Cost Concepts: The costs were classified into variable and fixed costs. The measurement and definition of various cost components are as follows:

Variable cost: Those costs which vary with the level of production are included in this category. The costs included are cost of inputs, labour cost, interest on working capital and miscellaneous costs.

Labour cost: The cost on human labour was calculated by multiplying the man-days with prevailing wage rate. Women days were converted into man days by multiplying it with the ratio of wages given to women labour to that of men labour. The cost on family labour was imputed by multiplying man days with the prevailing wage rate. The bullock labour was taken in pair days and the cost towards it was estimated by multiplying pair days with wage rate. Machine labour was measured in hours and valued at prevailing hourly rates in the area. Whereas, combine harvester and thresher chargers were considered only in monetary terms.

Cost of Inputs: Cost of various inputs like fertilisers, plant protection chemicals, FYM and others are included in this category. Non-farm inputs were valued at prevailing prices while owned farm inputs were imputed at current prices. The prevailing charge for canal water per crop per season was taken as irrigation cost (It is reported by the farmers that, they do not pay irrigation charges, however it is collected in different forms).

Interest on Working Capital: The prevailing bank rate of seven per cent (Commercial bank lending rate for crop loan in study area) is taken to work out the interest on working capital for the duration of the crop.

Miscellaneous: This item includes the cost incurred for miscellaneous purpose during farming operations.

Fixed Cost: This consists of those cost items which do not vary with the level of production. The items included under this section are;

Land Revenue and taxes: Land revenue was charged at the rates levied by the Government.

Depreciation: Depreciation on each farm asset used in the cultivation of crop was worked out by straight line method of computing depreciation.

$$\text{Depreciation} = \frac{\text{Purchase Value} - \text{Junk Value at the Life End of the Asset}}{\text{Average Life (in years) of the Asset}}$$

The average life of the asset as indicated by each farmer was used in computation of the depreciation.

Rental Value of Owned Land: The prevailing rental value of the land for the crop depending on the duration was considered.

Interest on fixed capital: It was computed at the rate of ten per cent per annum. The interest was worked out on the values of fixed assets, after deducting depreciation for the year and land revenue.

Returns Concept

Gross Returns: It includes the gross value of main product and by product imputed on the basis of post-harvest prices prevailing in the selected study area was considered in the present study.

Net Returns: It is computed by subtracting the gross returns from total cost of cultivation. Returns over variable cost were calculated by dividing gross returns by total variable cost. Similarly, returns per rupee of expenditure were calculated by dividing gross returns by total cost of cultivation.

Returns per rupee of expenditure: It was calculated by dividing the gross return by total cost of production of certified seeds.

Cost of Production: Cost of production was calculated by dividing total cost of cultivation by total crop output (Main product).

Resource use efficiency: Cobb-Douglas type of production function was used to analyse the resource use efficiency.

Specification of the equation for seed production is given in equation 1.

$$Y = a\, X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} e^{u} \qquad \ldots(1)$$

where, Y = Gross returns (₹)

X_1= Seed cost (₹)

X_2= FYM cost (₹)

X_3= Fertilizer cost (₹)

X_4= Plant protection chemical cost (₹)

X_5= Human labour cost (₹)

X_6 = Machine labour cost (₹)

X_7 = Area in acre

a and u represented constant and random variable, respectively, and b_1 to b_7 indicate regression coefficients of respective inputs and implicitly represents the elasticity of production of respective inputs.

Allocative efficiency: The estimated coefficients were used to compute the MVP. Marginal Value Product of X_i, i.e., for the i^{th} input, is estimated by the following formula,

$$MVP = b_i * \frac{GM(Y)}{GM(X_i)}$$

$GM(Y)$ and $GM(X_i)$ represent the geometric means of output and input respectively and b_i is the regression co-efficient of i^{th} input. The model was estimated as follows,

$$r = MVP/MFC$$

where, r = efficiency ratio

MVP = Marginal value product of variable input

MFC = Marginal factor cost (price per unit input)

The values are interpreted thus, If r is <1; resource is excessively used, r > 1; resource is under used and if r = 1; it shows the resource is efficiently used.

Technical efficiency

Technical efficiency (TE) defined as the ability of a farm to produce the maximum feasible output from a given level of inputs, or with the minimum feasible levels of inputs to produce the maximum level of output. The DEA method is the non-parametric mathematical programming approach for frontier estimation (Coelli, 1996) method that does not require specification of a functional form or a distributional form and can accommodate scale issues. DEA was applied by using VRS (variable returns to scale) with input orientation as constant returns to scale are only appropriate when the farms are operating at an optimal scale (Murthy *et al.* 2009).

Estimation of technical efficiency

$$\text{Min}\ \theta, \lambda\ \theta,$$

Subject to,

$$-y_i + Y\lambda \geq 0$$
$$\theta X_i - X\lambda \geq 0$$
$$\lambda \geq 0 \qquad \ldots(3)$$

where,

y_i is a vector (m×1) of output of the ith Producing Farms (TPF)

x_i is a vector (k x 1) of inputs of the ith TPF

Y is an output matrix (n×m) for n TPFs

X is an input matrix (n × k) for n TPFs

θ is the efficiency score, a scalar whose value will be the efficiency measure for the ith TPF. If θ =1, TFP (Total factor productivity) will be efficient; otherwise, it will be inefficient. λ is a vector (n × 1) whose values are calculated to obtain the optimum solution.

The DEAP version 2.1 software developed by Coelli (1996), Centre for Efficiency and Productivity Analysis, University of Queensland, Australia, was used in this study to compute the efficiency levels of red gram farms separately by taking input oriented method. The main product per hectare considered as outputs in the present study and seeds (kgs), farm yard manure (tons), human labour (Man days), bullock labour (pair days), machine labour (hours), chemical fertilisers (kgs), plant protection chemicals (in red gram) were taken as inputs. The prices of inputs used for cost minimization problem to estimate the economic efficiency (K. Suresh *et al.* 2016).

Estimation of Allocative and Cost Efficiency (Economic Efficiency)

One would run the following DEA formula for estimation of efficiencies as follows:

$$\text{Min } \lambda, X_{i*}\ W_i X_i^*,$$
$$\text{Subject to } -y_i + Y\lambda \geq 0,$$
$$X_i^* - X\lambda \geq 0,$$
$$N_1\lambda \geq 1$$
$$\lambda \geq 0, \qquad \ldots(4)$$

where, W_i is a vector of input prices for the ith Total Productivity Factor (TPF), X_i is the cost minimizing vector of input quantities for the ith RPF.

Given the input prices W_i and the output levels Y_i. The total Cost efficiency (CE) or Economic efficiency (EE) of the ith TPF would be calculated as,

$$CE = W_i X_i^* / W_i X_i \qquad \ldots(5)$$

i.e., the ratio of minimum cost to observed cost. One can then use following formula to calculate the allocative efficiency residually,

$$AE = CE / TE \qquad \ldots(6)$$

Garrett ranking technique: Garrett's ranking technique was used to rank the benefits and constraints in seed production. In this analysis, rank one meant most important factor and higher the rank meant least important factor. In the next stage, rank assigned to each factor by each individual was converted into per cent position using the following formula,

$$\text{Percent position} = \frac{100^*\ (R_{ij} - 0.50)}{N_j}$$

where, R_{ij} stands for rank given for the i^{th} factor (i = 1, 2……9) by the j^{th} individual (j = 1, 2 …..50) and N_j stands for number of factors ranked by j^{th} individual.

Once the per cent positions were found, the per cent position of each rank was converted to scores by referring to table given in Garrett and Woodsworth (1969). Then the scores for each factor were summed over the number of sample farmers who ranked that factor. In this way, total scores were arrived at for each of the benefits and constraints and mean scores were calculated by dividing the total score by the number of respondents, who gave ranks.

RESULTS AND DISCUSSION

Cost and returns in Red gram seed production

It can be observed from the Table 1 and Table 3 that the average working expenses incurred in BRG-1 and BRG-2 varieties was ₹ 42,671 per ha and ₹ 35,560 per ha, respectively. In BRG-1 varietal seed production, the major expenditure was incurred on human labour (32.55 %) followed by cost on machine labour (12.59 %) whereas in BRG-2 variety, expenditure on human labour (34.19 %) was highest followed by cost on FYM (9.09 %).

Table 1: Cost of cultivation of certified seed production of BRG-1 variety of red gram (Per ha)

Sl. No.	Particulars	Qty.	Unit cost (₹)	Cost (₹)	%
I	**Variable cost**				
	Seeds (kg)	12.8	73	935	1.59
	FYM (tractor load)	2.9	2310	6,699	11.36
	Fertilizer cost (₹)	—	—	4,123	6.99
	Plant protection chemical cost (₹)	—	—	852	1.44
	Labour (Man days)	64	300	19,200	32.55
	Machine Labour cost (₹)	—	—	7,426	12.59
	Bullock Labour (BP days)	2.12	940	1,993	3.38
	Interest on working capital@ 7 %	—	—	1,443	2.45
	Total variable cost			42,671	72.34
	Fixed cost				
II	**Depreciation**			**1,230**	**2.09**
	Land revenue	—	—	25	0.04
	Interest on fixed capital @ 10%	—	—	63	0.11
	Rental value of land	—	—	15,000	25.43
	Total fixed cost	—	—	16,318	27.66
III	**Total cost of cultivation (I+II)**			**58,989**	**100.00**

Fixed costs accounted for 27.66 per cent and 31.31 per cent of the total cost of cultivation in BRG-1 and BRG-2 varieties. Among fixed cost, rental value of land was major cost in both BRG-1 (25.43 %) and BRG-2 (28.98 %).

Cost of cultivation: The average cost of cultivation of BRG-1 and BRG-2 varieties of red gram seed production was ₹ 58,989 and ₹ 51,768 per hectare, respectively.

The gross return includes returns from accepted seeds and rejected seeds (Table 2 and Table 4). The per hectare average seed yield obtained of BRG-1 and BRG-2 varieties was 13.2 q and 11.3 q, respectively which was accepted by KSSC whereas the average yield rejected by KSSC was 2.2 q and 2.4 q, respectively.

Table 2: Returns from certified seed production of BRG-1 variety of redgram (Per ha)

Returns	**Quantity**	**Unit price (₹)**	**Value (₹)**
Main product			
a) Accepted product (q)	13.2	6,500	85,800
b) Rejected product (q)	2.2	3,243	7,135
Gross returns	—	—	92,935
Net returns	—	—	33,946
Cost of production (₹/q)	—	—	3,830
Return per quintal	—	—	6,035
Returns per rupee of expenditure	—	—	1.58

Table 3: Cost of cultivation of certified seed production of BRG-2 variety of redgram (Per ha)

Sl. No.	**Particulars**	**Qty.**	**Unit cost (₹)**	**Cost (₹)**	**%**
I	**Variable cost**				
	Seeds (kg)	12.7	73	924	1.78
	FYM (tractor load)	2.1	2,240	4,704	9.09
	Fertilizer cost (₹)	—	—	3,601	6.96
	Plant protection chemical cost (₹)	—	—	903	1.74
	Labour (Man days)	59	300	17,700	34.19
	Machine Labour cost (₹)	—	—	4,646	8.97
	Bullock Labour (BP days)	2.14	890	1,905	3.68
	Interest on working capital @ 7 %	—	—	1,177	2.27
II	**Total variable cost**	**—**	**—**	**35,560**	**68.69**
	Fixed cost				
	Depreciation	—	—	1,125	2.17
	Land revenue	—	—	25	0.05
	Interest on fixed capital @ 10 %	—	—	58	0.11
	Rental value of land	—	—	15,000	28.98
	Total fixed cost	—	—	16,208	31.31
III	**Total cost of cultivation (I+II)**			**51,768**	**100.00**

Table 4: Returns from certified seed production of BRG-2 variety of redgram (Per ha)

Returns	**Quantity**	**Unit price (₹)**	**Value (₹)**
Main product			
a) Accepted product (q)	11.3	6,500	73,450
b) Rejected product (q)	2.4	3,100	7,440
Gross returns	—	—	80,890
Net returns	—	—	29,122
Cost of production (/q)	—	—	3,779
Returns per quintal	—	—	5,904
Returns per rupee of expenditure	—	—	1.56

Table 5: Comparison between seed production and conventional production (Per ha)

Sl. No.	**Crop**	**Cost of cultivation**	**Net returns**	**Returns per rupee of expenditure**	**t value**
1	BRG-1	58,989	33,946	1.58	3.42*
2	BRG-2	51,768	29,122	1.56	
3	# Grain production	50,860	27,235	1.49	

Source: *#Akshatha, 2017.*
Note: **- Significance at 5 per cent.*

The net returns per hectare of BRG-1 and BRG-2 was ₹ 33,946 and ₹ 29,122, respectively.

The rate of return per rupee of expenditure was higher in case of BRG-1 variety (₹ 1.58) than in BRG-2 variety (₹ 1.56).

Seed and grain production: The comparison of seed production to grain production (Table 5) indicated higher returns in seed production in both the varieties. The returns per rupee of expenditure was ₹ 1.49 in conventional production (Akshatha, 2017) which was lower when compared to return per rupee of expenditure in BRG-1 (₹ 1.58) and BRG-2 (₹ 1.56) seed production. The results revealed that the seed production is profitable than grain production.

Resource use: The cost of fertilizers applied in BRG-1 (₹ 4,123) and in BRG-2 (₹ 3,601) variety was non-significant. The difference in cost of FYM, plant protection chemical cost, machine labour cost, seeds and bullock labour costs were significant (Table 6). The co-efficient of multiple determination (R^2) was 0.94 and 0.91 for BRG-1 variety and BRG-2 variety, respectively, indicating that independent variables included in the production function explained 94 per cent and 91 per cent of the variation in the production of BRG-1 and BRG-2 varieties of redgram seed production (Table 7).

Table 6: Resource use pattern in BRG-1 and BRG-2 varieties of red gram seed production (Per ha)

Sl. No.	Particulars	BRG-1		BRG-2		t value
		Qty.	Value (₹)	Qty.	Value (₹)	
1	Seeds (kg)	12.8	935	12.7	924	-1.12 ^{NS}
2	FYM (tractor load)	2.9	6,699	2.1	4,704	3.02**
3	Fertilizer cost	—	4,123	—	3,601	-0.07 ^{NS}
4	Plant protection chemical cost	—	852	—	903	0.64 ^{NS}
5	Human labour (Man days)	64	19,200	59	17,700	3.57**
6	Machine labour (₹)	—	7,426	—	4,646	-1.20 ^{NS}
7	Bullock labour (BP days)	2.12	1,993	2.14	1,905	1.03 ^{NS}

Note: **- Significance at 5 per cent; **- Significance at 1 per cent.*

Table 7: Estimates of Cobb-Douglas production function in BRG -1 and BRG -2 varieties of red gram certified seed production [Dependent variable (Y): Gross returns in rupees per farm]

Variables	Parameters	BRG -1	BRG -2
Intercept	a	275.68** (4.65)	339.75** (4.01)
Seeds cost (X_1)	b_1	-0.054 ^{NS} (-1.70)	-0.280 ^{NS} (-1.71)
FYM cost (X_2)	b_2	0.020** (3.02)	0.025 ^{NS} (1.09)
Fertilizer cost (X_3)	b_3	0.046 ^{NS} (1.84)	0.05** (2.83)
Plant protection chemical cost (X_4)	b_4	0.0008 ^{NS} (0.24)	0.026 ^{NS} (0.84)
Human labour cost (X_5)	b_5	0.211** (3.21)	0.410** (3.99)
Machine Labour cost (X_6)	b_6	0.008 ^{NS} (0.27)	0.104 ^{NS} (1.77)
Area in acre (X_7)	b_7	0.546** (3.59)	0.633** (3.46)
Co-efficient of multiple Determination	R^2	0.94	0.91
F value		1.52**	3.21866E-10**

Note: *1. *- Significant at 5 per cent; 2. **- Significant at 1 per cent; 3. Figures in parentheses represents 't' value.*

Resource use efficiency: In case of BRG-1 variety regression co-efficient of FYM (0.020), human labour (0.0008) and area (0.546) were statistically significant at one per cent. The regression co-efficient of other variables seeds (-0.054), fertilizer (0.046) and machine labour (0.008) were statistically non-significant. One unit increase in the input use of FYM, human labour and area above its geometric mean level will lead to 0.020, 0.0008 and 0.546 increase in gross returns (₹) from its geometric mean level, respectively. The overall regression model was found to be significant at one per cent. In case of BRG-2 variety regression coefficient of fertilizer (0.05), human labour (0.410) and area (0.63) were statistically significant at one per cent. If the significant variables fertilizer, human labour and area were increase by one unit above its geometric mean level, the gross returns (₹) will increases by 0.05, 0.410 and 0.63 from its geometric mean level. The overall regression model was found significant at one per cent.

Table 8: Resource - use efficiency in BRG-1 red gram certified seed production (per farm)

Variables	Input use at geometric mean level (₹)	Co-efficient	MVP	MFC	MVP/ MFC
Seeds cost	1,019	-0.054 ^{NS}	-4.8	1	-4.8
FYM cost	4,150	0.020**	0.44	1	0.44
Fertilizer cost	3,274	0.046 ^{NS}	1.29	1	1.29
Plant protection chemical cost	852	0.0008 ^{NS}	0.08	1	0.08
Human labour cost	18,095	0.211**	1.06	1	1.06
Machine Labour cost	7,492	0.008 ^{NS}	0.09	1	0.09
Area (acres)	3	0.541**	16,290	30,000	0.54

*Note: 1. **- Significant at 1 per cent.*

In BRG-1 variety, the ratio of MVP to MFC in case of FYM, human labour and area were 0.44, 1.06 and 0.54, indicating that the FYM and area were over utilised and human labour is underutilised, hence there is still scope to increase the human labour in production to get more returns (Table 8). In case of BRG-2 variety, the ratio of MVP to MFC of fertilizer and human labour were 1.49 and 1.58, respectively indicating on invest of one rupee on fertilizer and human labour would give additional gross returns of ₹ 1.49 and ₹ 1.58.

It is observed from Table 9 that under the assumption of variable returns to scale, in case of BGR-1 variety majority firms (73%) performed with technical efficiency level equal to score 0.9-1. In BRG-2 variety number of firms with technical efficiency equal to score 0.9-1 are 40 percent, which BRG-2 firms are technically less efficient than BRG-1 firms. With regard to allocative efficiency and cost efficiency in BRG-1 variety 24 firms and 13 firms have score equal to 0.9-1 respectively. BRG-2 firms again shown lesser allocative and cost efficiency by having only 5 and 4 firms in each efficiencies with range score 0.9-1 respectively. By the data it is evident that there is scope to reallocate the resources in BRG-2 varietal seed production firms.

Table 9: Technical, Allocative and Cost Efficiency of certified red gram seed producing farms of BRG-1 and BRG-2 varieties

Variety	BRG-1			BRG-2		
Efficiency	**TE**	**AE**	**CE**	**TE**	**AE**	**CE**
0.2-0.3	0 (0)	0 (0)	0 (0)	0 (0)	2 (6.66)	2 (6.66)
0.3-0.4	0 (0)	0 (0)	0 (0)	0 (0)	1 (3.33)	2 (6.66)
0.4-0.5	0 (0)	0 (0)	0 (0)	0 (0)	2 (6.66)	7 (23.33)
0.5-0.6	0 (0)	0 (0)	1 (3.33)	5 (16.67)	2 (6.66)	8 (26.66)
0.6-0.7	3 (10.00)	0 (0)	3 (10.00)	3 (10.00)	5 (16.66)	5 (16.66)
0.7-0.8	3 (10.00)	3 (10.00)	7 (23.33)	7 (23.33)	5 (16.66)	0 (0)
0.8-0.9	2 (6.66)	3 (10.00)	6 (20.00)	3 (10.00)	8 (26.66)	2 (6.66)
0.9-1	22 (73.33)	24 (80.00)	13 (43.33)	12 (40.00)	5 (16.66)	4 (13.33)
Total	30 (100)	30 (100)	30 (100)	30 (100)	30 (100)	30 (100)
Average	0.98	0.93	0.91	0.81	0.70	0.56

Note: *Figures in Parenthesis are percentage to total number of farmers; TE: Technical Efficiency; AE: Allocative Efficiency; CE: Cost / Economic Efficiency; Inputs Considered are seeds, human labour, bullock labour, FYM*

Garrett ranking results

Benefits: When farmers are requested to rank the factors due to which they take seed production over grain production,both BRG-1 and BRG-2 varietal seed producing firms awarded first rank to assured market by giving score 62 and 63 respectively, which shows farmers take seed production majorly because of assurance of market they get from Karnataka State Seeds Corporation Limited. Next factor due to which farmers take seed production under Karnataka State Seeds Corporation Limited is Seed Subsidy, farmers opined that they get seeds at subsidised rate which is another favourable factor to take seed production. Third rank is awarded to technical guidance, KSSC officials' regular visits at different stages of crop and guidance regarding transplanting, crop protection, harvesting and storage made a impact on them to continue the seed production. Remunerative price was ranked third followed by dividend as all seed growing farmers are not the members or shareholders of KSSC not everyone get the dividend every year hence it is ranked as last factor due to which they take seed production over grain production.

Fig. 1, shows that share capital that they get is not the major factor which favours the decision of taking seed production and both varietal seed producing farmers opined the assured market they get is the main reason to take up the seed production.

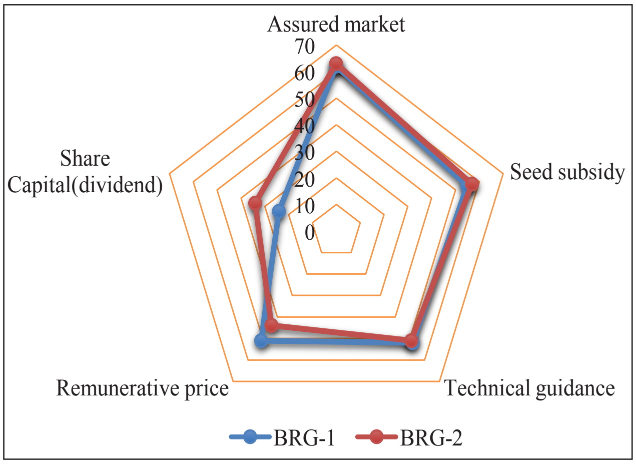

Fig. 1: Radar chart depicting benefits ranked by respondents of BRG-1 and BRG-2 redgram seed producers

Constraints: Constraints in seed production are grouped into four major categories naming General constraints, plant protection, credit, agro climatic factors, economic factors and institutional constraints. Farmers were asked to rank the constraints they face in each category one being the major constraint they face and 5 being the less problematic factors.

General Constraints: BRG-1 varietal seed producing farmers felt lack of agricultural labour during peak season is the major constraint whereas BRG-2 varietal seed producing farmers felt lack of pure and quality seeds is the major constraint, farmers feel BRG-2 seeds they get from KSSC are low quality seeds. Both the varietal seed producers opined availability of micro-nutrient fertilizers is not much a constraint to take seed production (Fig. 2).

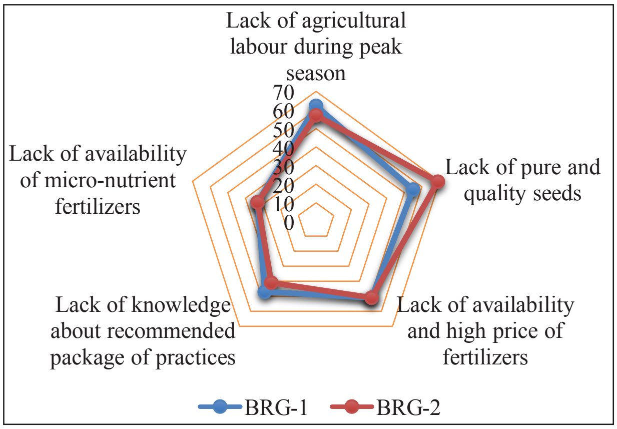

Fig. 2: Radar chart depicting general constraints ranked by respondents of BRG-1 and BRG-2 redgram seed producers

Plant protection constrains: Incidence of diseases in both the varieties is awarded first rank followed by pest incidence, noted that the availability of plant protection chemicals is not a major problem in the study area.

Credit Constraints: BRG-1 seed producing farmers felt complicated procedure of applying for credit from bank is the major constraint by giving a score of 60, while the BRG-2 seed producing farmers felt timely unavailability of credit is the major problem by awarding score of 62. Both the varietal seed growing farmers ranked second to the high transaction cost since they have to travel many times to banks which are not near to their residential areas. Farmers opined that they do not lack the knowledge about sources of capital around them including cooperative and commercial banks, hence gave less score (Fig. 3).

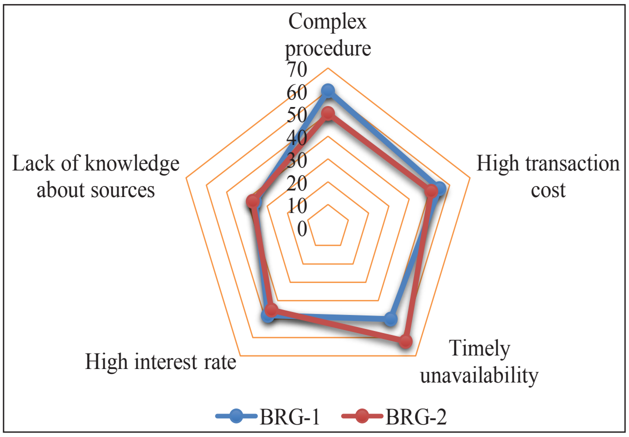

Fig. 3: Radar chart depicting Credit constraints ranked by respondents of BRG-1 and BRG-2 redgram seed producers

Agro-climatic factors: The major problem faced by farmers is drought during critical stages of growth, farmers who are not having bore wells are hiring water tankers to water the plants in critical stages. Excessive rain is felt as not a major problem by BRG-1 varietal seed producing farmers and variation of temperature is felt as not a major problem by BRG-2 varietal seed producing farmers.

Economic constraints: This category included two factors namely fixed price by procuring agency i.e., KSSC irrespective of market situation and high input cost. Among them both the varietal seed producing farmers awarded first rank to fixed price by giving high scores.

Institutional Constraints: BRG-1 and BRG-2 seed producing farmers gave scores of 52 and 60 respectively for poor quality of inputs, saying they get poor quality of inputs by KSSC is the major constraint in seed production in the study area. Both the varietal seed growing farmers opined that they get enough guidance and extension services like information regarding availability of seeds in agriculture office and updates about new technologies available in seed production.

Table 10: Opinion of respondents on the benefits in redgram seed production

Sl. No.	Particulars	BRG-1		BRG-2	
		Score	Rank	Score	Rank
1	Assured market	62	1	63	1
2	Seed subsidy	55	2	57	2
3	Technical guidance	52	3	51	3
4	Remunerative price	51	4	44	4
5	Share Capital (dividend)	24	5	34	5

Table 11: Opinion of respondents on the constraints in redgram seed production

Sl. No.	Particulars	BRG-1		BRG-2	
		Score	Rank	Score	Rank
(A) Production constraints					
1. General Constraints					
	Lack of agricultural labour during peak seasons	62	1	57	2
	Lack of pure and quality seeds	55	2	69	1
	Lack of availability and high price of fertilizers	51	3	51	3
	Lack of knowledge about recommended package of practices	47	4	41	4

Lack of availability of micro-nutrient fertilizers	33	5	33	5
(2) Plant protection constraints				
High incidence of diseases	57	1	59	1
High incidence of insect pest.	53	2	49	2
Lack of availability of genuine plant protection chemicals	39	3	40	3
(3) Credit constraints				
Complex procedure	60	1	50	3
High transaction cost	55	2	51	2
Timely unavailability	50	3	62	1
High interest rate	48	4	45	4
Lack of knowledge about sources	36	5	37	5
(B) Agro climatic Factors				
Drought during Critical stages of growth	71	1	73	1
Variation in temperature	69	2	52	3
Excessive Rain	61	3	46	2
(C) Economic Constraints				
Fixed price of procurement agency irrespective of Market situation	63	1	57	1
High input cost	36	2	43	2
(D) Institutional Constraints				
Poor quality of inputs	52	1	60	1
Poor Extension services	39	2	24	2

RESULTS

Results have amply indicated the superiority of seed production over grain production in both the varieties. The human labour in BRG-1, fertilizers and human labour in case of BRG-2 varieties had ratio MVP/MFC of more than one, indicating their underutilization and hence the profitability can be increased by using more of these resources. The technical efficiency (0.98), allocative (0.93) and economic efficiency (0.91) of BRG-1 farms were more than in BRG-2, which showed 0.81, 0.70 and 0.56 technical, allocative and economic efficiencies, respectively, indicating the scope to reallocate the resources, so efforts are needed to educate farmers about seed production and package of practices which also leads to increase in yield and profitability in seed production. Constraints analysis indicated that labour scarcity at peak season was the major constraint as seed production is labour intensive, hence farm mechanization must be encouraged, particularly during the peak seasons to ward off labour supply demand gap, further extending custom hiring services would help in addressing labour problem. This study reveals that adoption of certified seed production of redgram in farmers' fields is helpful in providing a profitable enterprise for increasing the net farm income.

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Prospects of Custard Apple Value Chain Development in Rajasthan

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ABSTRACT

Custard apple is one of the wildly found perishable crop of forest areas. Rajasthan is one of the top ten custard apple growing states in our country. In Rajasthan, custard apple is mainly found in southern districts of Rajasthan. The present study was carried out to analyze prospects of value chain development in custard apple marketing in Rajasthan. The secondary data has been obtained and analyzed from Directorate of Horticulture, Government of Rajasthan for the year, 2017-18. The perishable nature of custard apple makes difficult to transport it to distant places thereby tribals are forced to sell the fruit at throwaway prices i.e. approx. ₹ 10/Kg on roadsides. It was observed that interventions involving improved cultivation practices and reduction in post harvest losses would increase the production level by 50 per cent and 20 per cent, respectively, whereas value addition activities through processing would give better returns to the processors as well as to the tribal harvesters The study further highlighted compound annual growth rate of custard apple area and production along with the need of investments in research & development to ensure improved cultural practice to establish custard apple orchards to increase yield per hectare, introduction of improved varieties, processing technology and overhauling of the value chain.

Highlights

- Value chain development help in increasing the shelf-life of perishable fruits.
- Upliftment of the socio- economic status of tribal households dependent on custard apple collection from forest areas.

Keywords: Custard apple, value chain, interventions, socio-economic status.

Custard apple, *Annona squamosa* (Sweetsop, Sitaphal, Sharifa, Ates), is most widely grown species of *Annonaceae* family, originated and introduced in India from Tropical America. In India, total area* under custard apple was 44 thousand hectare which led to production* of 367 thousand MT whereas Rajasthan had an area* of 241.65 hectares (0.54 per cent) and production* of 1481.49 MT (0.40 per cent) under custard apple during 2017-18, which signified that Rajasthan holds an important role in area and production of custard apple (Annual Report, Directorate of Horticulture, Government of Rajasthan, 2018).

It is of great importance for tribals of the state as it widely grows in tribal belts of Rajasthan which includes areas of Udaipur, Chittorgarh, Jhalawar, Dungarpur, Bhilwara and Rajsamand districts.

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** The actual area and production under custard apple may vary, as custard apple is wildly grown horticultural crop of forest areas, therefore, it is very difficult to quantity the actual area and production of it.*

During 2017-18, Udaipur district was having highest area of 109 hectares with the production of 525 MT of custard apple. Chittorgarh district was leading in terms of production of custard apple during 2017-18 with total area of 79 hectare and 746 MT of production of custard apple (Annual Report, Directorate of Horticulture, Government of Rajasthan, 2018). It meets the economic needs of tribal population who are dependent on its marketing. Due to perishable nature of custard apple tribals collect the custard apple and sell them on roadsides at very low price i.e., less than ₹ 10 per Kg (Final report, National Agriculture Innovation Project, 2013). During 2018-19, custard apple sold in the market at varying prices depending upon the time of sale. In the morning hours of the custard apple season the fruit was sold at ₹ 60 per Kg whereas in the same evening prices reduced to ₹ 20 per Kg. This huge variation in prices depicts the highly perishable nature of fruit. Therefore, there is a need to make tribal people who are collecting custard apple from forest area acquainted with processing and marketing practices which further would lead to higher output, employment and profit for years (Tripathi, 2016). There is very little investment in custard apple processing, despite the fact it will give them better economic returns. This fruit can be processed into various value added products such as ice creams, faluda, squashes, shrikhand, basundi, shakes. Investment in processing into value added pulp and various other products will greatly reduce the waste experienced especially during the season of glut (Reddy *et al.* 2010).

METHODOLOGY

Rajasthan is one of the leading producers of custard apple in the country. The present study focuses on compound annual growth rate in area and production of custard apple along with SWOT analysis of custard apple value chain, the model value chain of custard apple and efforts towards its development and challenges and strategies for harnessing the potentials of custard apple for the development of tribal community of Southern Rajasthan.

Sampling Procedure: For calculation of price spread in custard apple marketing by tribals, Udaipur city of Rajasthan was purposively selected as the city was serving as largest market of custard apple. For calculation of price spread a sample of 25 tribals was purposively selected who were directly selling custard apple in Udaipur city area.

Analytical Tools: For analyzing the compound annual growth rate of area and production the exponential function was used.

$$Y = ab^t e^{Ut} \qquad ...(1)$$

Where, Y= Area/ Production of custard apple

a = intercept, b = regression coefficient, U_t = stochastic coefficient in year t

Log linear form of equation (1) is:

$$\log Y = \log a + t \log b + U_t \qquad ...(2)$$

Ordinary Least Square (OLS) technique was used to estimate equation (2)

Compound annual growth rate was calculated as:

$$g = (b - 1)\, 100$$

where, b = antilog of log b

g = compound annual growth rate (in per cent per annum)

Price Spread: Various measures of price spread would be calculated as follows:

Share of tribal in consumer rupee= Price received by tribals excluding marketing cost/ price paid by consumer

Value added = Price paid by consumer – total cost of marketing

RESULTS AND DISCUSSION

Rajasthan is one of the leading producers of custard apple in the country. The compound annual growth rate indices for area and production of custard apple in Rajasthan and India can be depicted from Table 1.

Table 1: Compound annual growth rate of custard apple (CAGR in per cent per annum)

	Rajasthan		India	
Year	Area (th. Ha)	Production (th. MT)	Area (th. Ha)	Production (th. MT)
2011-12	0.90	6.80	18.50	127.30
2012-13	0.87	7.11	19.55	135.64
2013-14	0.58	5.65	21.77	165.15
2014-15	0.53	4.56	29.87	228.37

2015-16	0.52	6.12	36.83	289.01
2016-17	0.54	4.28	44.00	383.00
2017-18	0.24	1.48	46.00	401.00
2018-19	0.21	1.40	40.00	338.00
CAGR	-18.19**	-20.66**	15.35**	19.57**

Source: *Indiastat.com, Directorate of Horticulture, Rajasthan.*
***significant at 5 per cent level of significance.*

The area and production of custard apple in Rajasthan witnessed negative growth rate of -18.19 per cent and -20.66 per cent per annum, respectively, which signified that there must be shift in cultivation of crops towards some other crop. On the other hand the area and production of custard apple in the country witnessed positive growth rate of 15.35 per cent and 19.57 per cent, respectively. it can be concluded that in the country as a whole custard apple showed increase in level of area and production whereas in Rajasthan, there existed fall in area and production of custard apple. The decrease in area and production led to increase in demand for value added products due to shortage of fruit in the market so that the product can be stored for longer time (Kallega *et al.* 2015).

Marketing of custard apple: Tribals market the fruit at nearby cities or road sides. The perishable nature of custard apple makes it difficult to transport it to distant places. The amount received was also lower due to small shelf life. The price spread in marketing of custard apple to nearby cities/ roadsides is shown in table 2.

Table 2: Price Spread in marketing of custard apple

Particulars	Amount (₹ per quintal)	Percentage
Amount received by tribals	1835.00	83.40
Collection charges	135.00	6.13
Transportation	85.00	3.86
Packing Material/ Basket charges	110.00	5.00
Losses	35.00	1.60
Total cost in marketing	365.00	16.59
Amount Paid by consumer	2200.00	

Source: *Author's Calculation.*

It can be depicted from Table 2 that the tribals were having 83.40 per cent share in consumer's price paid whereas 16.59 per cent was incurred as marketing cost. Although the share received was high due to non interference of middlemen but the amount received was less which signified opportunity for value chain development. Similar results were observed in the findings of Mishra *et al.* (2014).

Value Chain Development: The major issues which the tribals face are: (a) lack of rejuvenation technology, (b) harvest and post harvest losses, (c) lack of processing technologies and value addition and (d) unorganized market. To overcome various challenges in marketing of custard apple, development of value chain is of utmost importance. It helps to increase the shelf life of the fruit. Value chain describes the analysis of all the activities which are essential to bring a product or service from point of conception, through the different phases of production/ marketing (involving a combination of physical transformation and value addition through processing, etc.) and then followed by final disposal after use (Final report, National Agriculture Innovation Project, 2013). The various steps involved in custard apple value chain are shown in Fig. 1.

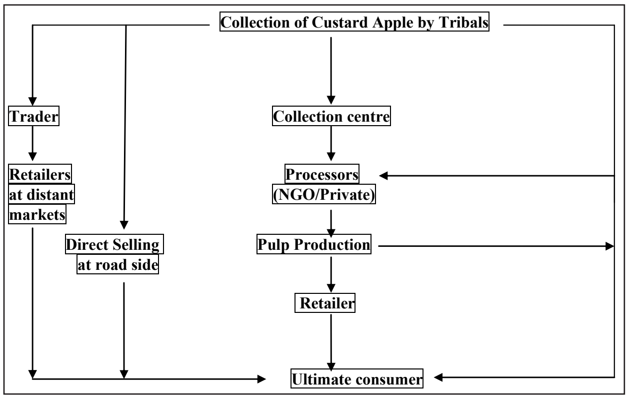

Collection of Custard Apple by Tribals
Trader
Collection centre
Retailers at distant markets
Processors (NGO/Private)
Direct Selling at road side
Pulp Production
Retailer
Ultimate consumer

Fig. 1: Value chain for Custard Apple

SWOT Analysis: The first step in development of short and long term strategic planning is to analyze various internal and external factors affecting the performance of value chain of custard apple which is done by SWOT analysis. SWOT analysis of custard apple value chain to evaluate strength, weaknesses, opportunities and threats in the process is shown in Table 3.

There are various threats and weaknesses as enlisted mentioned in the above table which are hampering the development of value chain of this precious fruit. Custard apple is the gift of nature to the tribals as it grows wildly without much investment and climatic conditions of the Southern Rajasthan also make it favourable to grow over there.

Table 3: SWOT Analysis of Custard Apple Value Chain

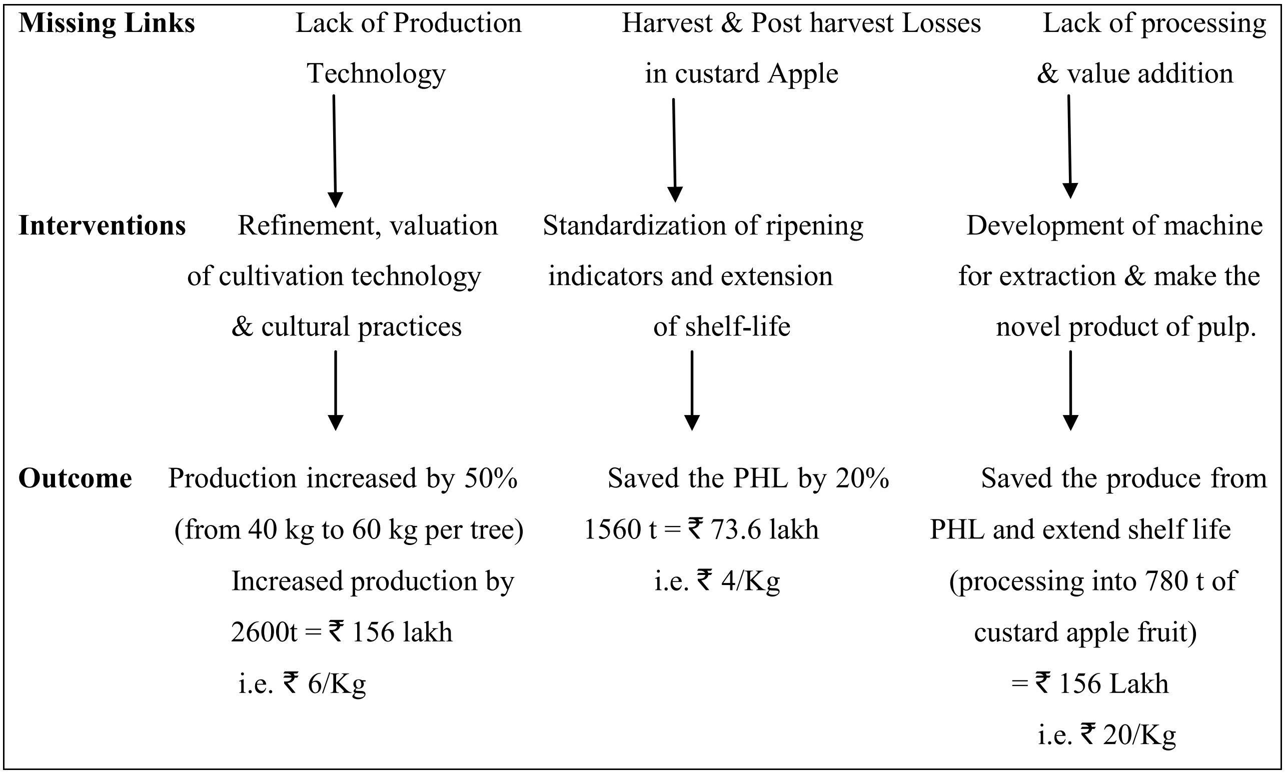
Strengths	Low cost of production Low labour cost Suitable climate of Southern Rajasthan Growing market of the product
Weaknesses	Custard apple production naturally found in limited area Tribals do not undertake its cultivation Lack of market information Lack of expertise High pre & post harvest losses Lack of infrastructure/ storage units Lack of capital Unorganized market channels High transportation cost Low R & D capability Lack of vision and policy Lack of interaction with stakeholders
Opportunities	Reduction in post harvest losses Improvement in quality of product High processing opportunities High product value High by- product value Longer shelf life Well organized structure for storage Better returns Employment Generation in processing units.
Threats	Climate change Non availability of funds for setting up processing units in the area Potentially high R & D expenses Inconsistent Government policies Lack of competitiveness in the market.

Therefore, there is need to focus upon the strengths and opportunities provided by value chain to uplift the socio- economic status of the tribals of the area. Particularly, interventions and policies must be introduced in such areas where the custard apple cultivation is undertaken or the tribals are mainly dependent on its collection from forest areas for their livelihood.

Impact of interventions on Value Chain of Custard Apple: In order to ensure that the tribals receive better prices for their produce the intervention involving value addition to the fruit before selling it in the market is required. The strategy of value addition on agricultural produce provides ample opportunity for revenue generation, employment generation and effective post harvest management. The processing of raw fruit into various innovative products like pulp, powder, etc. promotes market acceptability and gives the products high economic value (Kaushik, 2013). Experts from MPUAT, Udaipur provided technical support for this intervention. It started with training the tribals about right stage of harvesting i.e when the fruit slightly turned yellowish in colour followed standardized rejuvenating technology, pulp extraction equipment developed and browning free technology was adopted for the processing of custard apple, which helped in increasing the shelf life of finished product from a few days to more than a year. It involved the establishment of collection centre at village level, processing unit, a storage unit and marketing network to promote sale of the produce. Tribals were provided training on the maturity indices and processes like grading, sorting, weighing, processing, etc. (Kaushik, 2013). The impact of interventions are shown in Fig. 2 which are based on the production of custard apple from 4000 hectare of project area (including custard apple grown in forest area) under NAIP in Rajasthan.

Value Addition at State level: Value chain basically consist of series of value adding activities which led to the improvement in quality of product being marketed and also results in better returns to the functionaries involved at each level (Kaplinsky and Morris, 2001). In India, total area under custard apple was 44 thousand hectare which led to production of 367 thousand MT whereas Rajasthan had an area of 241.65 hectares (0.54 per cent) and production of 1481.49 MT (0.40 per cent) under custard apple during 2017-18 (Annual Report, Directorate of Horticulture, Government of Rajasthan, 2018). Table 4 shows value addition and increase in the income level by implying the outcomes of intervention as indicated in figure 2 to the state level production during the year 2017-18.

From the calculations in table 4, it can be concluded that after all the possible interventions value of custard apple would increase by ₹ 115.21 Lakhs from ₹ 74.07 Lakhs. If the improved practices at production level, management of post harvest losses and 10% of the total production is processed (as


Missing Links
Lack of Production Technology
Harvest & Post harvest Losses in custard Apple
Lack of processing & value addition
Interventions
Refinement, valuation of cultivation technology & cultural practices
Standardization of ripening indicators and extension of shelf-life
Development of machine for extraction & make the novel product of pulp.
Outcome
Production increased by 50% (from 40 kg to 60 kg per tree) Increased production by 2600t = ₹ 156 lakh i.e. ₹ 6/Kg
Saved the PHL by 20% 1560 t = ₹ 73.6 lakh i.e. ₹ 4/Kg
Saved the produce from PHL and extend shelf life (processing into 780 t of custard apple fruit) = ₹ 156 Lakh i.e. ₹ 20/Kg

Source: *Technology on custard apple processing and value chain: A step towards doubling the income of tribals (Kaushik, 2013)*

Fig. 2: Impact of interventions on the value chain of custard apple

Table 4: Economics of Value Chain of Custard Apple

Parameter	Amount
Total Area under custard apple in the state (during 2017-18)	241.65 ha
Total Production (during 2017-18)	MT
Value of 1481.49 MT custard apple (@ ₹ 5/Kg)*	₹ 74.07 Lakhs
If interventions implied as suggested by MPUAT experts (Under NAIP)	
Increase in Production by improved practices (50% of production hike)	740.74 MT
Hike of Production in Value terms (@ ₹ 6/Kg)*	₹ 44.44 Lakhs
Total production after opting improved practices	2222.23 MT
Saving in Post Harvest Losses (20%)*	444.44 MT
Post harvest losses reduced in Value terms (@ ₹ 4/Kg)*	₹ 17.77 Lakhs
Overall Production level after interventions	2666.67 MT
Value of 2666.67 MT custard apple (a+b+c)	₹ 136.28 Lakhs
Value Added by Processing (If 10% of production is being processed into pulp i.e. 266.66 MT, @ ₹ 20/Kg)	₹ 53 Lakhs
Total Returns (a+b+c+d)	₹ 272.56 Lakhs
Possible Value Addition by all interventions (b+c+d)	₹ 115.21 Lakhs

** Calculations done on the basis of Fig. 2 (Kaushik, 2013 and Kaplinsky and Morris, 2001).*

given in Fig. 2) then the value of total returns from custard apple to state during 2017-18 would be ₹ 272.56 Lakhs which included ₹ 53 Lakhs of value addition by processing.

Strategies towards harnessing the potentials of custard apple in Rajasthan: Rajasthan state of India is blessed with natural biodiversity of the crop with more than 50 per cent of state's forest area situated under Aravalli Hills. The wild land races of custard apple are found distributed all along as a natural stand over an acreage of approximately 673 hectares in the Aravalli range of forest scattered across Udaipur, Rajsamand, Chittorgarh, Kota, Baran and Jhalawar districts (Bhatnagar, 2016). Custard apple is one of the species of *Annonaceae* family which wildly found in the forest areas. It is generally found growing spontaneously in wild forests, scrub jungles, rocky slopes as a semi-wild fruit in Southern Rajasthan. Out of total near about 30% of the produce go waste in transportation or post harvest losses. Therefore, if the state is to take advantage of the huge potentials of this underutilized fruit, the following strategies have to be implemented:

(a) Control over the post harvest losses,

(b) Training should be given on harvesting indicators and post harvest handling of fruit,

(c) Adequate funding for research and development,

(d) Establishment of processing units and collection centers and

(e) Establishment of custard apple orchards with high yielding varieties.

CONCLUSION

There is a vast scope for the development of tribals who are dependent on custard apple collection from the forest areas (Tripathi, 2016). But the need is to acquaint them about the various losses and strategies to mitigate them. The technology developed by the experts of MPUAT is a crucial and advantageous step towards development of value chain of this underutilized fruit. Investments in processing units will have a great multiplier effect as it will not only improve the state's economy, but will also ensure creation of employment and enhance the income and living standards of all the actors in the value chain. At the root of the problem is research and development. All levels of the value chain require investments in the research and development to ensure improved cultural practices to establish custard apple orchards to increase yield per hectare, introduce improved varieties, processing technology and overhauling of the value chain.

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Constraints Perceived by the Farmers of Himachal Pradesh in Organic Farming

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ABSTRACT

Organic farming is one among the broad spectrum of production methods that are supportive of the environment through minimizing the use of chemical inputs and through use of on-farm resources efficiently. The present study was conducted in all the four zones of Himachal Pradesh with one representative district from each zone. Three blocks from each district was selected and from each block 12 organic farmers were selected. Thus, a sample size of 144 organic farmers was selected from all the four agro-climatic zones of Himachal Pradesh. Pre- tested schedule was used to collect relevant information from the farmers. Garret ranking technique was employed to prioritize the imminent constraints like production, marketing and ecological constraints. Highly severe constraints that were being faced by the farmers-practicing organic farming in the study area were small land holding, decline in crop productivity, higher incidence of pests and diseases, non availability of market place, lack of minimum support prices for organic products, wild animals menace, less erratic monsoon, fluctuation in temperature and humidity. These factors highlight the weak links, which need to be strengthened for promoting organic farming widely.

Highlights

- Highly severe constraints with the highest Garret Mean score in Himachal Pradesh were non availability of market for organic produce (84.00) followed by small land holdings (80.06).

Keywords: Organic farming, Garrett's ranking, production constraints, marketing constraints, ecological constraints

Himachal Pradesh is one of the hill states of India which lies in the western Himalaya. Agriculture is way of life,a tradition which for centuries has shaped the thought, the outlook, the culture and economic life of Himachalis. Himachal Pradesh is the only State in the country whose 89.96 per cent population lives in rural areas. Therefore dependency on Agriculture/ Horticulture is eminent as it provides direct employment to about 69 per cent of total workers of the State (Economic Survey of Himachal Pradesh, 2019-20). As part of their subsistent farming operations farmers in Himachal Pradesh have been traditionally dependent on organic ways of farming. Over the decades, it resulted in success stories of viable farming by small hill farmers on their marginal farmlands, until the time when farmers started experiencing new problems, decline in organic matter of the farmlands, increasing pest incidence of ever new kinds, increasing cost of cultivation, climate change based impacts on agriculture etc. To counter these problems and increase the productivity, farmers of

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the state started using the synthetic form of nutrients that are found deficient in soil or kill the pest and weed with poisonous pesticides & weedicides. This resulted in damaged soils, expensive and needless farming inputs, water-intensive/water-pollutive, lethal and ecologically harmful farming practices (all of which emanate from chemical farming) and do no good to agricultural advancement and to public health. Modern organic farming is thus being developed as a response to the environmental harm caused by the use of chemical pesticides and synthetic fertilizers in conventional agriculture. The growth of organic farming is relatively slower despite the fact that it is the best solution to the environmental problems such as climate change, health and sustainability issues that we are facing today due to conventional farming. In hill regions, small farm holders face a number of constraints in practicing organic farming. The major constraints faced by them were economic and marketing including initial low price for the organic produce, lack of specialized market, initial yield loss and high transportation cost. These constraints need to be overcome by appropriate interventions.

Sharma and Pathania (2011) explained that there is a growing awareness among the dry temperate hill farmers to cultivate crops under organic farming system because of escalating cost of inorganic fertilizers, decreased soil fertility, environmental and health hazards due to pesticide uses and expected premium prices for organically produced crops. There were also many factors which act as deterrents for organic farming. The present analysis is based on such factors. The identification of such factors highlights the weak links, which need to be strengthened for promoting organic farming widely. The analysis is pre-dominantly based on the responses of organic farmers.

DATA AND METHODOLOGY

Primary Data were collected from the organic farmers of all the four agro-climatic zones of Himachal Pradesh for the agricultural year 2019. One district from each agro-climatic zone was selected purposively. Una (Shivalik Hill Zone), Solan (Mid Hill Zone), Shimla (High Hill Zone) and Kinnaur (Cold Dry Zone) districts were chosen. Three blocks from each selected district were purposively selected, on the basis of maximum area under organic farming in consultation with district level officers,then accordingly four villages from each block was chosen purposively. After selection of village, three organic farmers were selected randomly from each village. Accordingly, 12 households were selected from each block thus making total sample size of 144 organic farmers from four agro-climatic zones of Himachal Pradesh. For the selection of sample, three stage stratified random sampling design was adopted; with development block as a primary unit, village as a secondary unit and sampled farmer as an ultimate unit. Garrett's Ranking Technique was used to prioritize the imminent challenges/constraints.

Garrett's Ranking Technique

Per cent Position = 100 (R_{ij} -0.50)/ N_{ij}

Where, R_{ij} = Rank given to the i^{th} item by the j^{th} individual,

N_{ij} = Number of items ranked by the j^{th} individual,

The per cent position of each rank was converted into scores using Garrett's table. For each constraint score of the individual respondent were added. Thus, mean score for each constraint was ranked by assigning higher rank (1) to highest value of Garrett mean score.

RESULTS AND DISCUSSION

Constraints/ Challenges

Important constraints being faced by farmers practicing organic farming systems in the selected area are divided into four major categories ie Production constraints, Marketing constraints, Ecological constraints and other than these in Other constraints,are presented in table – 1, 2, 3 and 4.

Production constraints: It may be seen that at overall level small land holding was reported as major constraint with rank 1 (Table 1). It was also highly severe problems in zone-III and zone-IV. There is a preponderance of small land holdings in Himachal Pradesh. According to Agricultural Census of Himachal Pradesh (2010-11), small and marginal farmers together constitute 88% of the total population of the state. The average size of holding was 1.0 hectares in 2010-11. Second largest constraint being faced by organic farmers is decline in crop productivity for which farmers

Table 1: Production constraints being faced by the farmers in the study area

Sl. No.	Constraints	Zone-I		Zone-II		Zone-III		Zone-IV		Over all	
		GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank
1	Small land holding	80.50	II	80.81	III	79.58	I	79.36	I	80.06	I
2	Decline in crop productivity	78.67	IV	84.17	I	79.28	II	77.14	II	79.81	II
3	Non availability of seed material	64.00	XIV	59.86	XV	67.72	XIII	66.61	XIII	64.54	XIV
4	Non availability of organic manures	68.92	VII	62.94	XII	68.47	XI	75.17	III	68.87	X
5	Non availability of biopesticides	64.00	XV	60.44	XIII	65.42	XV	64.39	XV	63.56	XV
6	Higher incidence of pests and diseases	80.50	III	80.19	IV	77.75	IV	70.50	IX	77.23	III
7	Non availability of water for irrigation	86.00	I	81.72	II	75.61	VI	65.06	XIV	77.09	IV
8	Less-fertile soil	67.36	XI	70.72	VIII	65.53	XIV	70.11	X	68.43	XI
9	Costly labour	75.31	VI	79.58	V	78.67	III	72.33	VI	76.47	V
10	Lack of skilled labour at operation period	68.28	VIII	67.06	X	70.72	VIII	73.64	IV	69.92	VIII
11	Lack of information on organic farming	67.78	X	65.53	XI	68.14	XII	70.75	VIII	68.05	XII
12	Lack of technical guidance	67.11	XII	67.36	IX	72.72	VII	71.33	VII	69.63	IX
13	Lack of awareness about organic practices to control the pest and diseases	66.14	XIII	78.14	VI	69.97	X	72.86	V	71.77	VII
14	Think that local conditions are conducive for inorganic farming	67.97	IX	60.00	XIV	70.72	IX	67.06	XII	66.43	XIII
15	Fluctuating production	76.83	V	71.50	VII	76.22	V	69.19	XI	73.43	VI

GMS*- *Garret Mean Score.*

Table 2: Marketing constraints being faced by the farmers in the study area

Sl. No.	Constraints	Zone-I		Zone-II		Zone-III		Zone-IV		Over all	
		GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank
1	Lack of all weather roads	63.61	X	64.33	X	67.83	XI	80.39	II	69.04	IX
2	Inadequate storage facilities	77.28	V	71.94	VII	77.17	V	77.83	IV	76.06	V
3	Price instability	77.56	IV	77.44	II	77.06	VI	73.78	IX	76.46	IV
4	High transport charges	69.28	VIII	73.83	VI	80.22	IV	77.61	V	75.24	VII
5	Distant markets	78.17	III	75.78	V	81.50	II	78.44	III	78.47	III
6	Malpractices by traders at the time of auction	69.56	VII	67.25	VIII	75.06	VII	77.17	VI	72.26	VIII
7	Lack of availability of institutional credit	68.33	IX	64.03	XI	65.94	XI	64.78	XIII	65.77	XI
8	Lack of market intelligence	62.00	XII	62.81	XII	65.33	XII	67.81	XII	64.49	XII
9	Non-assurance of getting income	76.00	VI	76.47	IV	73.72	VIII	75.06	VIII	75.31	VI
10	Lack of minimum support prices for organic products	79.33	II	77.33	III	80.67	III	76.78	VI	78.53	II
11	Inaccurate weighing instruments.	62.00	XIII	61.25	XIII	62.00	XIII	67.92	XI	63.29	XIII
12	Non availability of market place exclusively for organic produce	84.00	I	84.00	I	84.00	I	84.00	I	84.00	I
13	High commission charges	62.28	XI	67.08	IX	69.06	IX	72.33	X	67.69	X

GMS*- *Garret Mean Score.*

should always be ready to take risk. This constraint was also found as major constraint with rank I & II in different zones. Higher incidence of pests and diseases was the third largest constraint at state level expressed by the farmers. It was found more severe in three zones i.e., zone-I, zone-II and zone-III. The pests and diseases management with organic means is complex and needs holistic and systematic approach. The capacity building on these aspects needs to be addressed through various research and extension programmes and should be pest and location specific. There were also several other constraints like non availability of water for irrigation, costly labour, fluctuating production, Lack of awareness about organic practices to control the pest and diseases etc which were ranked in their ascending order as 4th, 5th, 6th and so on respectively.

Marketing constraints: In organic farming most important constraint reported by the farmers that they were facing was the problem of marketing. Non availability of market place exclusively for organic produce was the major constraint with rank I in all the four zones of Himachal Pradesh (Table 2). Almost all the farmers in the study area expressed their anguish for lack of marketing facilities. Prabu (2008) stated that the lack of genuine marketing infrastructure was a big problem for the growers. Though organic farming has been proved to be low investment technology for growing crops, marketing organically produced crops has not been an easy task especially for some farmers. He also opined that lack of information on marketing channels and absence of proper governmental guidelines has forced many of them to sell their produce for a throwaway price. Roshan (2010) stated that the problems encountered in the marketing of organic produce have also hindered its growth in the country. It is very important that organic produce is marketed at a premium price over conventional produce, so that it becomes viable for farmers to adopt these methods regularly on a large scale. There is huge international demand for organic produce, but so far, the output in India has been insufficient to meet this demand. Lack of minimum support prices for organic products is playing their role in proving a constraint for organic farming and is hence, ranked second. Bishnoi *et al*. (2020), conducted a study in Kurukshetra and Panipat districts of eastern zone and Hisar district of western zone in the state of Haryana. These districts were selected on basis of acreage under summer mungbean. The analysis of constraints in cultivation of summer mungbean as opined by the sampled farmers recite that non-availability of suitable machine for harvesting, non-procurement of produce by Govt. agencies, harvest price less than MSP were recorded as the major constraints in the study area. Distant markets, price instability and inadequate storage facilities were another highly severe problems related to marketing which were ranked 3rd, 4th and 5th respectively at state level in the study area. Price fluctuation is a multifaceted problem attributed by various factors which, when combined, culminate in dangerous consequences for the most vulnerable. Although high prices can technically be good news for farmers, price fluctuation is extremely dangerous, as farmers and other agents in the food chain risk losing their investments if prices fall. Traditional harvesting and storage conditions of Indian farms and farmers result in large proportions of crop wastage. It has been estimated that crop wastage due to inefficient storage is 7 per cent of annual grain production per year in India. This percentage accounts for 21 million tonnes of wheat grain alone, as India lacks proper cold storage and cold chain transportation (Suprem *et al*. 2013). These affected the promotion of organic farming. There are a number of constraints impeding small farm holders in India for adopting organic farming. Major apprehension lies in non-availability of sufficient amount of organic supplements, bio-fertilizers and local market for organic produce (Pandey and Singh, 2012, Samantaray *et al*. 2009). Mohanty *et al*. (2013) have also reported the major constraints like lack of regular soil testing, lack of mechanization in agriculture, poor knowledge of IPM, lack of innovativeness, lack of entrepreneurial ability, lack of low responsiveness, absence of storage facilities, postharvest technologies and lack of effective supervision and monitoring by extension workers for adoption of technologies for vegetable production being perceived by the tribal farmers of north Sikkim.

Ecological constraints: The farming community is facing several threats due to environmental changes and pollution. Crop damages due to climatic changes are putting a lot of pressure on the farmers. The cultivation of high value crops, especially horticultural crops, has started showing increasing symptoms of unsustainability due to, among other things, falling soil fertility, erratic weather conditions and the emergence of numerous insects, pests and diseases. The adoption of same cropping sequence year after year has caused the loss of micronutrients leading to deterioration in the overall soil health. Land use pattern in the state of Himachal Pradesh in the Indian Western Himalayas has been undergoing rapid modifications due to changing cropping patterns, rising anthropogenic pressure on forests and climate changes. In the study area irregular monsoon showed a deep impact in all the zones (Table 3). Monsoon plays a crucial role in Indian agriculture. Most farmers rely on good crop produce during monsoon to earn their living and in order to overcome debts incurred. This further cements the importance of monsoon in an agrarian economy like India. Agriculture in Himachal too is largely dependent on monsoon and as such production of crops fluctuates year after year due to irregular monsoon. At the state level, problem of irregular monsoon has thus been ranked first. Fluctuation in temperature and humidity was also found out to be a major constraint in study area and was ranked second instate as well as at individual zones.

Table 3: Ecological challenges related to farming being faced by the farmers in the study area

Sl. No.	Constraints	Zone-I		Zone-II		Zone-III		Zone-IV		Over all	
		GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank
1	Climate not suitable	76.33	III	74.22	III	65.64	IV	54.08	V	67.57	III
2	Soil erosion	51.53	VII	52.97	VII	60.31	VI	65.33	I	57.53	VI
3	Loss of water holding capacity	53.78	V	53.75	VI	57.00	VII	52.19	VI	54.18	VII
4	Soil contamination with Pesticides and others	51.78	VI	61.42	V	65.56	V	51.33	VII	57.52	V
5	Less erratic monsoon or the distribution of rains is not as per the requirements.	78.00	I	77.67	I	74.67	I	64.67	II	73.75	I
6	Fluctuation in temperature and humidity	78.00	II	75.67	II	73.00	II	60.44	III	71.78	II
7	Wind and hail storms	72.25	IV	62.53	IV	70.58	III	60.36	IV	66.43	IV

GMS*- *Garret Mean Score.*

Table 4: Other constraints related to farming being faced by the farmers in the study area

Sl. No.	Constraints	Zone-I		Zone-II		Zone-III		Zone-IV		Over all	
		GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank	GMS*	Rank
1	No local processing facilities	68.56	II	64.11	II	59.22	III	66.33	I	64.56	II
2	Wild animals menace	70.81	I	69.89	I	68.56	I	49.67	IV	64.73	I
3	Certification process is expensive and complicated	43.00	IV	35.33	IV	47.28	IV	56.72	III	45.58	IV
4	Too technical	45.56	III	55.61	III	59.44	II	58.33	II	54.74	III

GMS*- *Garret Mean Score.*

Other constraints: Wild animals menace was found as the major constraint at state and also in different agro climatic zones with the highest mean score (Table 4). The menace of wild and stray animals has emerged as one of the greatest challenges in the recent past. Damage to crops by wild and stray animals specially monkeys is being reported from many parts of the state. The issue has been highlighted even at the legislative assembly many times. The farmers are facing the crop damage problems due to the crop raiding by wild animals. Secondly, there were no local processing facilities available in the study area. Consumption of processed products started since time immemorial. Agricultural product processing plays an important role in food and its preservation. The agro processing unit focuses on product research and development for the transformation of local produce into value added agricultural products as well as the transfer of technology for agri business development to improve income generation and food security but due to lack of local processing units in the study area, the farmers are unable to reap these benefits.

CONCLUSIONS

It is evident from the study that the transition towards organic farming is not without constraints, especially for small land holders. Thus, for encouraging the production and efficient marketing of organic crops, various problems and constraints in their production and marketing with which they are confronted with, were identified. There were many factors which act as deterrents for organic farming. The highly severe production constraints being faced by the farmers in the study area were small land holding, decline in crop productivity, higher incidence of pests and diseases, non availability of water for irrigation and costly labour which were rankled 1st, 2nd, 3rd, 4th and 5th by using Garret ranking method. The study has confirmed that marketing constraints like non availability of market place (1st), lack of minimum support prices for organic products (2nd) and distant markets (3rd) were significantly associated with the organic crop production. Major ecological constraints found in the study area were irregular monsoon and fluctuation in temperature and humidity. Other emerging challenges like wild animals menace and lack of local processing facilities pose a serious threat to the economic viability and ecological sustainability of the process of crop production in the state. If these constraints are removed by effective planning and its execution at ground level, the results can be fruitful both for the farmers as well as the economy as whole.

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Growth Performance of Oilseeds Among Leading States in India

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ABSTRACT

The present study was conducted to estimate the growth & instability of major edible oilseeds production across major states in India. The time series secondary data on area, production and productivity of soybean, rapeseed, mustard and groundnut were collected for all the major states from the period 1995-96 to 2017-18. Statistical tools like compound growth rate for calculating annual growth rate and Cuddy-Della Valle Index for instability index were used. Results showed that the area and production of soybean in Madhya Pradesh and Maharashtra increased at a highly significant rate annually. Instability of area in both these states was found low. Production and productivity of rapeseed and mustard in Haryana, Rajasthan, Madhya Pradesh were found to be increased at highly significant annual growth rate but the area in Uttar Pradesh was declined at a highly significant rate per annum (-2.93%). Instability of area in Haryana and Uttar Pradesh was low and production instability was moderate in all four states whereas except Haryana, all three states showed low instability in productivity. In groundnut Andhra Pradesh, Tamil Nadu, Maharashtra and Karnataka showed a highly significant decline in the annual growth rate of area and production. Except for Rajasthan, all other five states showed low instability in the area under groundnut during the study period. Therefore, the study recommends adoption of site-specific scientific package of practices of the crop to avoid the prevailed instability.

Highlights

- Area and production of soybean in Madhya Pradesh & Maharashtra increased at highly significant rate
- Productivity of rapeseed mustard in all the major states increased at highly significant rate

Keywords: Compound growth rate, instability, Cuddy-Della Valle Index, significant, production, area, productivity

India is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural economy of the country. India produces a variety of crops belonging to cereals, pulses, oilseeds, fruits and vegetables, condiments, sugar, fibres, narcotics etc. Oilseed crops are the most important commercial crops of India (Soni Kumari, 2012). In terms of acreage, production and economic value, these crops are second after food grains (Narayan, 2016). India is blessed with varied agro-ecological environments ideally suited for growing a variety of oilseeds which include groundnut, rapeseed and mustard, sunflower, soybean, sesamum, safflower, castor, linseed and Niger seed, two perennial oilseeds (coconut and palm oil). India occupies the place of pride as the world's largest producer of groundnuts, sesamum, linseed and castor seeds (Reddy and Immanuelraj, 2017). In the world, India stands at 4th position in soybean area with share of 8.6 per cent to the total

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area and in production it occupies 6th position with 3.8 per cent share. In groundnut area, India stands at 1st position in the world with share of 14.9 per cent where as in production it occupies 3rd position with share of 10.5 per cent. In rapeseed & mustard area India stands at 2nd position with 15.2 per cent share whereas in production it occupies 4th position with share of 9.5 per cent (FAOSTAT, 2018). In India total area of oilseeds was accounted for 24507.90 th.ha whereas production was 31459.26 th.t with yield of 1283.63 kg/ha. Highest share (27.10 per cent) in area was contributed by Madhya Pradesh state followed by Maharashtra with 16.87 per cent and in production highest share was contributed by Madhya Pradesh with 22.09 per cent followed by Rajasthan with 19.43 per cent. Out of 9 oilseeds, 7 are edible (Soybean, Rapeseed & Mustard, Groundnut, Sesamum, Sunflower, Safflower, Niger seed) and 2 are non-edible (Castor seed & Linseed). Out of these 7 edible oilseeds only Soybean (36.79), Groundnut (31.13) and Rapeseed & Mustard (28.37) contributes to 96.29 per cent of production share in India.

In soybean, Madhya Pradesh and Maharashtra states are contributing most to the production compared to other states i.e.; 48.67 and 34.8 per cent, respectively. In rapeseed & mustard, Rajasthan and Haryana states are the top 2 states which are contributing maximum to the production i.e., 42.01 and 13.14 per cent, respectively. Where as in Groundnut, Gujarat and Rajasthan are the top 2 states with maximum contribution to the production in India with 42.6 and 13.6 per cent, respectively (DACNET, 2017-18).

Hence there is a need to fill this gap between production and consumption of oilseeds due to the increased demand. Therefore, this study on major edible oilseeds becomes important for the policy makers and planners to emphasize on these crops to fulfil the per capita need through increased production via latest technologies and high yielding varieties and also thereby cutting on imports to reduce import bill of the country. The present paper was undertaken with the objective to estimate the growth & instability of major edible oilseeds production across leading states in India.

MATERIALS AND METHODS

Study area and crops

The area of study comprises of all those states which covered >80% of major edible oilseeds production in India. Out of 7 edible oilseeds, major 3 edible oilseeds have been selected as they shared >80% of the production in India according to 2016-17 data. Bulk line method was used for selection of these crops and states.

Crops	States
Soybean	Madhya Pradesh, Maharashtra
Groundnut	Rajasthan, Andhra Pradesh, Tamil Nadu, Maharashtra, Karnataka, Gujarat
Rapeseed & Mustard	Haryana, Rajasthan, Madhya Pradesh, Uttar Pradesh

Period and source of data

The present study is based on secondary data and the required time series data were collected from Directorate of Economics and Statistics. The period of the study is from the year 1995-96 to 2017-18.

Statistical tools

Statistical tools like compound growth rate and Cuddy-Della Valle Index were used to analyze growth rates and instability in area, production and productivity of major oilseeds in India respectively.

Compound growth rate

It is calculated as;

C.G.R. (%) = (Antilog b – 1) *100

where, b = regression coefficient

Cuddy Della Valle Instability index

(Cuddy and Della Valle 1978) is a modification of coefficient of variation to accommodate trend present in the data, which is commonly present in economic time series data. This method is superior over the scale dependent measures such as standard deviation. The Cuddy Della Valle index (CDVI) is calculated as follows:

Cuddy - Della Valle Index (%) = $C.V.*\sqrt{(1-R^2)}$

where, C.V. = Coefficient of Variation

R^2 = Coefficient of multiple determination

The ranges of CDVI (Sihmar, 2014) are given as follows:

Low instability = between 0 and 15

Medium instability = greater than 15 and lower than 30

High instability = greater than 30

RESULTS AND DISCUSSION

Table 1 depicted the extent of growth and instability in area, production and productivity of soybean in major states like Madhya Pradesh and Maharashtra during the year 1995-96 to 2017-18. The compound growth rate of soybean in area under Madhya Pradesh showed highly significant positive rate with 1.72 per cent of growth per annum. In the same way production of soybean in the state also showed highly significant growth rate of 2.52 per cent per annum. But the productivity of soybean in the state didn't showed any significant results although increased with positive growth rate of 0.79 per cent per annum.

The compound growth rate of area under soybean in Maharashtra was found to be increased at highly significant rate with 8.72 per cent of growth per annum. In the same way production of soybean in the state also showed highly significant growth rate of 7.44 per cent per annum. But the productivity of soybean in the state surprisingly showed insignificant negative results with growth rate of -1.18 per cent per annum.

The instability index was calculated by Cuddy-Della Valle Index for area, production and productivity of soybean in states like Madhya Pradesh and Maharashtra. Results showed that in Madhya Pradesh variation in area under soybean registered low instability (12.83%) whereas production and productivity of soybean in the state registered variation with high instability of 37.98 and 31.61 per cent respectively.

In Maharashtra CDVI results depicted that variations in area under soybean was having low instability with 10.41 per cent as of in Madhya Pradesh but production and productivity of soybean in the state during the study period showed variations of medium instability with 26.68 and 19.53 per cent respectively which was lesser than the variations found in Madhya Pradesh.

Growth and instability in area, production and productivity of rapeseed & mustard in major states like Haryana, Rajasthan, Madhya Pradesh and Uttar Pradesh during the year 1995-96 to 2017-18 were analysed and presented in Table 2. The area of rapeseed & mustard in Haryana during the study period showed negative growth rate with -0.21 per cent per annum. But the production and productivity of the crop in the state registered highly significant positive growth rate with 1.99 and 2.21 per cent per annum.

Table 1: Growth & instability of area, production and productivity of soybean in major states of India during 1995-96 to 2017-18

Sl. No.	States	CGR (%)			CDVI (%)		
		Area	Production	Productivity	Area	Production	Productivity
1	Madhya Pradesh	1.72**	2.52**	0.79	12.83	37.98	31.61
2	Maharashtra	8.72**	7.44**	-1.18	10.41	26.68	19.53

Source: *Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.*

***significance at 1 per cent level (highly significant) * significance at 5 per cent level (significant).*

Table 2: Growth & instability of area, production and productivity of rapeseed & mustard in major states of India during 1995-96 to 2017-18

Sl. No.	States	CGR (%)			CDVI (%)		
		Area	Production	Productivity	Area	Production	Productivity
1	Haryana	-0.21	1.99**	2.21**	13.02	17.35	15.38
2	Rajasthan	0.28*	2.79**	2.50**	23.08	23.90	10.52
3	Madhya Pradesh	1.05	3.18**	2.11**	16.29	21.05	11.09
4	Uttar Pradesh	-2.93**	-1.47**	1.50**	10.53	16.48	11.97

Source: *Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.*

***significance at 1 per cent level (highly significant) * significance at 5 per cent level (significant).*

In Rajasthan all three variables such as area, production and productivity depicted highly significant positive growth rate with 0.28, 2.79 and 5.50 per cent per annum respectively. The increase in output growth is mainly driven by increase in yield which could be attributed to improved technology, adoption of good agronomic practices and input use. The results are in conformity with the results of Kumar *et al.* (2018). In Madhya Pradesh only, area under the crop showed insignificant positive growth rate with 1.05 per cent per annum but the production and productivity of the crop in the state during the study period registered highly significant positive growth rate of 3.18 and 2.11 per cent per annum respectively. Area and production of rapeseed & mustard in Uttar Pradesh during the study period found to be declining with highly significant growth rate of -2.93 and -1.47 per cent per annum but the productivity of the crop in the state showed positive growth rate of 1.50 per cent per annum which was highly significant.

Instability index results showed that variation in area of rapeseed and mustard in Haryana state was low with 13.02 per cent but the production and productivity of the crop in the state during the study period showed medium instability with 17.35 and 15.38 per cent respectively. Area and production of rapeseed and mustard in Rajasthan showed medium instability with 23.08 and 23.90 per cent. But the productivity of the crop was found to show low instability with 10.52 per cent. The low and moderate instability indicate that the development of new technology over years and favourable policy environment have played major role in stabilizing area, production and yield of rapeseed mustard in Rajasthan state as found by results of Kumar *et al.* (2018).

Area and productivity instability of rapeseed and mustard in Uttar Pradesh was found to be low with 10.53 and 11.97 per cent respectively but the production instability was moderate with 16.48 per cent.

Table 3 indicated growth rate and instability index for area, production and productivity of groundnut in major states across India during the study period. It was found that area and production of groundnut in Andra Pradesh declined with highly significant growth rates of 4.02 and 4.26 per cent per annum respectively during the study period. But the productivity of the same didn't show any significant results. As per as instability is concerned the variation in area of the crop was found to be low with 12.83 per cent but production and productivity of the crop in Andra Pradesh showed high instability with 37.98 and 31.61 per cent respectively.

In Karnataka, there was highly significant negative growth rate in area and production of groundnut with -3.32 and 3.72 per cent per annum respectively. But productivity showed insignificant negative growth rate. Area instability was found to be low with 10.41 per cent but instability of production and productivity was moderate with 26.68 and 19.53 per cent respectively. The decrease in supply of groundnut and high instability is attributed to decrease in area and productivity because the crop area has been switched to cash crops like sugarcane, cotton etc. The droughts and insufficient monsoon rains have also affected the production and productivity of oilseeds in Karnataka as results found in Behera & Basavaraja, (2017).

Table 3: Growth & instability of area, production and productivity of groundnut in major states of India during 1995-96 to 2017-18

Sl. No.	States	CGR (%)			CDVI (%)		
		Area	Production	Productivity	Area	Production	Productivity
1	Andra Pradesh	-4.02**	-4.26**	-0.25	12.83	37.98	31.61
2	Karnataka	-3.32**	-3.72**	-0.42	10.41	26.68	19.53
3	Gujarat	-1.02**	3.43*	4.50**	8.67	43.33	39.28
4	Maharashtra	-2.98**	-2.57**	0.21	9.61	15.38	8.96
5	Rajasthan	4.13**	10.14**	4.35**	18.42	50.87	25.73
6	Tamil Nadu	-5.29**	-1.46*	4.05**	10.64	24.64	16.26

Source: *Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.*

***significance at 1 per cent level (highly significant) * significance at 5 per cent level (significant).*

Area of groundnut in Gujarat registered declining but highly significant growth rate of -1.02 per cent per annum during the study period. Production and productivity of groundnut showed highly significant positive growth rate with 3.43 and 4.50 per cent per annum, respectively in the state. CDVI results showed that instability of production and productivity of groundnut in Gujarat was high with 43.33 and 39.28 per cent, respectively, but the area instability was found to be low with 8.67 per cent. The study by Sanjay *et al.* (2018), therefore, recommended the development and spread of innovations at an affordable price to farmers. Effective disease and pest control measures should be developed to check the perennial pest infestation of crop in the state.

Only a few states like Haryana, Madhya Pradesh, Maharashtra, Rajasthan and West Bengal have increased their oilseeds production both through area expansion and productivity improvement. State like Gujarat has increased oilseeds production mainly due to productivity improvement as found in results of Narayan, (2016).

Area and production of groundnut in Maharashtra was found to be declined at highly significant rate with -2.98 and -2.57 per cent per annum respectively. But the productivity showed insignificant positive growth rate. According to CDVI results low instability was noticed in area and productivity where as moderate instability found in production of groundnut in the state. Low instability may be due to technological and other government interventions according to results of Reddy and Immanuelraj, (2017).

Area, production and productivity groundnut in Rajasthan during the study period was found to be increased at highly significant growth rate of 4.13, 10.14 and 4.35 per cent per annum respectively. Variations in area and productivity were found to be moderate whereas high instability was noticed in production. Highly significant and significant negative growth rate were found in area and production of groundnut in Tamil Nadu with -5.29 and -1.46 per cent per annum respectively but productivity was increased at highly significant growth rate of 4.05 per cent per annum. Area instability was low with 10.64 per cent whereas production and productivity showed medium instability with 24.64 and 16.26 per cent respectively. Hence, the study by Pallab *et al.* (2015) highly recommends the use and adoption of site-specific scientific package of practices of the crop to avoid the prevailed instability.

CONCLUSION

Oilseeds are significant following only to food grains in terms of area; production and value and play a vital role in food and nutritional security of the country. India is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural economy of the country. Soybean, rapeseed & mustard and groundnut are the major oilseed crops sharing more than 80 per cent of production in India. Productivity level of Rabi season oilseeds (Rapeseed & Mustard) is higher than *Kharif* season oilseeds (Soybean & Groundnut) due to lower pest problem and assured irrigation availability**.** It can be noted from the study that soybean has performed well in terms of area and production in both the major producing states but the instability was found to be moderate to high in production and yield which indicates irregular rainfall and drought conditions. Production and yield of rapeseed & mustard in all major states were found to be performed well and also the instability in these states was low to medium. Only in Uttar Pradesh, the area and production were found to be performed negatively because of the shifting of the crop to barley and wheat. Area and production of groundnut in all the major states were found to be performed negatively because of the shifting to crops like bajra, paddy and cotton. Fluctuations in production and yield were also high which may be due to abiotic factors like rainfall, temperature and humidity etc.

Hence some of the recommendations based on the present study are:

- there is a need to provide proper irrigation facilities along with timely alerts on weather forecast
- providing proper incentives and subsidies to the farmers for growing essential major oilseeds.
- adoption of site-specific scientific package of practices of the crop to avoid the prevailed instability.

- development and spread of innovations at an affordable price to farmers. Effective disease and pest control measures should be developed to check the perennial pest infestation of crops in the state.

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AESSRA

Analysis of Demand Supply and Production Constraints in Major Fruits & Vegetables in Bihar

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ABSTRACT

The paper is an attempted to analyzed the trend in area, production and productivity and change in consumption pattern of fruits and vegetables across different socio-economic groups. Further, the future needs of vegetables and fruits as well as constraints faced by the farmer in production and marketing in the selected districts of state were also assessed. Trend analysis of area and, production of major fruits in Bihar indicated that area under major fruits shown an increasing trend. Production and productivity of litchi and banana also showed an increasing trend. Except mango whose production and productivity over period i.e. 2005-2012 had been declined. Whereas growth in area under major vegetable had been stagnated except for potato whose area had been declined over 2005-2012. Data of five major round i.e. 38th, 43t, 50th, 95th and 66th pertaining to the periods of 1983-84, 1988, 1993-94, 1999-2000, 2005-06 and 2009-10 respectively, shown a positive growth in annual per capita expenditure on fruits and vegetables and found to be more in urban areas than in rural areas.. Results of the study revealed that vegetables have emerged as an essential commodity recording income elasticity of demand lower than most of non-cereal commodities, while fruits continued to be more elastic. The demand of vegetable would be increase from 12.12 million tonnes in the year 2011 to 17.46 million tonnes in the year 2031, whereas the demand for fruits will be increased from 4.55 million tonnes (2011) to 6.55 million tones in the year 2031. This demand could be met by increasing the productivity of vegetables and fruits alone given the limitation of area expansion. The projected supply of major vegetables indicated that Bihar shall be surplus state in vegetable production and remained to be a surplus state in 2031. Study also revealed that 90 per cent of farmers were facing the problems of inadequate knowledge of market information system, and dis-satisfaction from price of fruits and & major constraints identified for vegetable were unavailability of cold storage facility; lack of processing plant in the state etc. Whereas senile orchard, lack of adequate knowledge of maintenance, unavailability of fund and input were highly significant constraints for production of these crops in the state.

Highlights

- The demand and supply projection of major fruits indicated that Bihar as a whole being a deficit state.
- Efficient vegetable co-operative with credit and marketing linkages is required to enhance the bargaining power of producers.
- Major constraints of Fruits & Vegetables marketing are low price spread, low bargaining power, and lack of market information.

Keywords: Demand and supply, exponential function, fruits and vegetables, Kendall's test

Production of fruits and vegetables is being viewed as 'Sunrise' enterprise meaning thereby that potentials of major fruits and vegetables in large. During 2012-13, Bihar produced 4.25 million tonnes of fruits and 16.32 million tonnes of vegetables, accounting to 5.23 per cent and 10 per cent of the country's production, respectively. Bihar ranked ninth in area under fruits (4.32%) and 3rd in area under vegetables (9.36%) as compared to all India's situation. The productivity of fruits (14.09 tonnes/

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ha) and vegetables (18.94 tonnes/ha) of the state is quite higher than the average productivity of the country's situation with 11.64 tonnes/ha and 17.62 tonnes/ha, respectively (Government of India, 2015).

Among different fruits grown in the state mango is the most important fruit crop accounting more than 50 per cent total area under fruits. Bihar rank third with respect to area and production of mango in the country. Next to mango, litchi has immense production and export potentiality in Bihar. Bihar holds a monopoly position in litchi production in terms of both quantity as well as quality. Amongst different litchi growing states, Bihar ranks first with respect to area production and productivity. Banana is another important fruit grown in the state. Bihar ranks 6th in production (1.70 million tonnes) and 7th in area and productivity of Banana in the country (NHM, 2014). Among vegetables potato, tomato, cauliflower, okra and brinjal is being grown on commercial level in the state. Trend in area, production and productivity over the period i.e. 1991-1992 to 2011-12 indicated that the area under vegetables has increased by 0.93 lakh hectares only however productivity has been increased from 10.2 tonnes/ ha. to 18.1 tonnes/ha. With increase in availability, a shift in consumption pattern in favour of fruits and vegetables was observed for all the socio-economic groups living in rural and urban area (Kumar and Mathur 1996; Kumar, 1998). It is hypothesized that urbanization, economic and population growth made shift in dietary pattern and enhanced the future demand of fruits and vegetables. With trade liberalization and increase in investment in horticultural development the prospects of export as well as for the processing industries of fruits have brightened (Kumar, 1998). But due to absence of practice of grading, poor quality, low yield level, lack of market integration, lack of infrastructure etc., the state has not been able to make significant contribution in the export as compared to other states of the country. Therefore future strategy for development would require a remarkable change in supply and demand scenario in fruits and vegetables of Bihar.

This paper seeks to examine the demand supply gap and identify the constraints and prospects in production and marketing of fruits and vegetable in Bihar. It is necessary because Bihar is the third largest producer of vegetables and these are becoming increasingly important in the state economy owing to its vast growth potential and assurance of livelihood to a large number of farm families. The genesis of the study further lies in fact that there is hardly any comprehensive survey based study related to consumption pattern conducted in Bihar which could help in improvement in the pattern of production, consumption and marketing prospects of this economically most backward state of India.

METHODOLOGY

Type of data and sampling methods

The present study was conducted during the year 2010 to 2013 based on both primary and secondary data. The time series data on the area, production, and productivity of major fruits (mango, litchi and Banana) and vegetables (okra, Cauliflower, Tomato and Potato) was collected from 11 districts having highest area under fruits and vegetables from Directorate of Horticulture, Bihar, Directorate of Economics and Statistics, Govt. of Bihar/or Census office, Govt. of India, different published sources and authentic online sources to study the trend in area, production and productivity, and to project the demand and supply of fruits and vegetables in Bihar.

Primary data, to identify the production and marketing constraints, sum total of 440 farmers of 44 village consisting of 10 farmers from each villages of 22 blocks of11 districts were collected through structured, pretested interview schedule employing multistage sampling technique. In the first stage, eleven districts having highest area under fruits and vegetables were selected purposively. At the second stage, two blocks from each district were selected randomly. At the next stage, two villages from each block i.e., a total of 44 villages consisting of 10 farmers from each village's i.e., 440 farmers were selected purposively for the same.

Tools and techniques employed for analysis of data

The trend in demand and supply of fruits and vegetables was estimated by employing the exponential function in the form of $y = ab^t$. The equation thus fitted to examine the trend in growth rate is converted to semi-logarithmic form represented as follows:

$$Log\ Y = A + BT \qquad \ldots(1)$$

Where, Y denotes area/production/yield, T indicates year (time), A and B are the coefficients, r = [Antilog (B) –1] × 100.

Demand requirement of fruits and vegetables was estimated on the basis of estimated trend by taking into considerations of per day/ capita consumption of fruit and vegetables respectively which has been taken in to account for fruit is about 120 gm/day and for vegetable 320 gm/day for all groups (ICMR).

To determine supply wastage allowance at the rate of 30% for mango and litchi while 20 per cent for banana of gross production and 19 to 22 per cent for rest of vegetable was taken into account however for tomato it was estimated at 39 per cent of gross production (Chaddha, 1995). Expenditure elasticity of fruit for rural and urban sector were estimated on the basis of collected NSS data by fitting logarithmic function of the type log $y_i = log\ a + b\ log\ xi$.. Lastly Kendall's rank coefficient of concordance test was used to find out the significant constraints faced by the farmers in production and marketing of fruits and vegetables (Siegel, 1966).

$$W = \frac{12\Sigma\left(R_i - R\right)^2}{k^2\left(N^3 - N\right)}$$

Where,

W = Kendall's coefficient of concordance

R = Mean of ranks assigned to the constraints

R_i = Rank given to the i^{th} constraints and

N = Number of farmers selected

k = Number of sets of ranking

The identified constraints were ranked accordingly and were weighted according to preference given by a group of farmers consisting of 24 farmers in each group irrespective of level of income, and size of holding having 10 groups,.

RESULTS AND DISCUSSION

It may be observed from the table that the area, production and productivity of major fruits in Bihar like mango showed compound growth rate of 1.05, -3.85 and -2.43 per cent respectively during the period which were significant at 1 per cent level of probability. This clearly indicated that though there was decline in production and productivity of mango but area under mango was registered positive and significant in the state of Bihar.

Table 1: Compound growth rate of area and production of major fruits and vegetables in Bihar 005-2010)

Crop	Area	Production
Mango		
Slope	1.01	0.96
Intercept	139.70	1222.34
CGR	1.05	-3.85
Litchi		
Slope	1.02	1.01
Intercept	28.4	206.27
CGR	2.07	1.69
Banana		
Slope	1.03	1.10
Intercept	28.24	1006.91
CGR	3.09	10.58

Source: *Compiled by the authors.*

However, other selected fruits such as litchi and banana shown positive and significant growth in its area, production and productivity over same mentioned period. The C.G.R. of area production and productivity of litchi and banana showed its growth of 2.07, 1.69 and 0.49 per cent for litchi and 3.09, 10.58 and 9.06 per cent respectively for banana. It may further be observed that area, production and productivity growth for both fruits (litchi and banana) were positive and significant during the period. District wise analysis indicated that the growth rate of area, production and productivity of mango in all most all selected districts i.e. 11 districts shown same trend as shown in the appendix-1 except for the district Rohtas, in which area and production both were positive (i.e. 0.55, 0.42 and -0.13) but productivity growth of mango was negative unlike other selected districts and state as a whole too (Table 1). It may further be observed that the highest growth in area under mango was observed in Vaishali (0.80 per cent) followed by Madhubani (0.72) and Siwan (0.70) and lowest growth in area was observed in Darbhanga (0.31) followed by Banka 0.42) and East Champaran (0.44%) respectively but production and productivity growth in all most all districts selected so far were shown negative trend during same period under study. In case of litchi, highest increase in area was observed in West-Champaran (10.16 %) followed by Samastipur (4.24 %) and Katihar (2.79 %), Purnea (1.95 per cent), Siwan (1.87 per cent) and was estimated lowest in Muzaffarpur i.e. 0.% followed by Vaishali (0.86 %) and East-Champaran (0.99 %). It clearly indicates that those districts which has highest immense production potential for litchi had further no scope for expansion in area. It was mainly due to fact that production and productivity was declined over the period due to old plantation of this crop.

Table 2: Growth rate of area and production of major vegetables in Bihar

Vegetables	Area	Production
Tomato		
Slope	1.00	1.07
Intercept	46.12	778.23
CGR	0.44	7.87
Cauliflower		
Slope	1.00	1.03
Intercept	59.62	955.80
CGR	0.94	3.13
Okra		
Slope	1.00	1.01
Intercept	56.16	703.56
CGR	0.96	1.55

Source: *Compiled by the authors.*

The area, production and productivity of major vegetables in Bihar shown a positive growth in area, production and productivity except potato, whose area, production and productivity was declined over period. District-wise trend analysis indicated that except Nalanda district in which the trend in area shown positive growth for potato i.e. about 0.06 per cent, in all other selected districts the area, production and productivity was declined. It was mainly due to unavailability of disease free high yielding varieties of seed, lack of storage facility (cold storage facility not available near by the villages) having low market price, post-harvest losses etc. However, other selected vegetable like tomato, cauliflower and okra shown positive and significant growth in production and productivity but area under vegetables was stagnated over the same period. For tomato it was estimated about 0.44 per cent and for cabbage (1.37 per cent), cauliflower (0.94 per cent) respectively in the state.

District-wise analysis indicated that area under tomato in almost all selected district shown an increasing trend except in E. Champaran where growth in area shown declining trend. The highest growth of area was registered in Samastipur district i.e. about 0.87 per cent followed by Begusarai (0.51 per cent) and East Champaran (about 0.45 per cent) respectively. However highest growth in area under cauliflower and okra was observed in Nalanda (3.03 per cent) and E. Champaran (5.63 per cent) for okra respectively. The lowest growth in area of these were observed in Madhubani i.e. about only 0.74 per cent and Begusarai (-1.99%) for cauliflower and okra respectively. Data pertaining to production and productivity of tomato, cauliflower and okra indicated that among selected district Patna shown highest growth rate of production i.e. about 10.59 per cent followed by West Champaran (10.36 per cent) and Nalanda (9.72) but lowest growth in production of tomato was estimated in Vaishali (8.27 per cent) followed by Aurangabad (8.29 per cent), Begusarai (8.41 per cent) and Muzaffarpur (8.78) respectively. For cauliflower, Nalanda districts were identified one of the important district, which shown highest growth in area, production and productivity and it was estimated to be 3.03, 6.41 per cent and 3.18 per cent respectively.

However, lowest growth in area, production and productivity was found in Madhubani i.e. about only 0.74 per cent and for production and productivity it was estimated to be 2.77 and 1.63 per cent respectively in Muzaffarpur district (D.R. 2013). It may further be observed from the table that trend in area and production of Okra was estimated to be 0.96 and 1.55 per cent respectively for state as a whole. This was found positive and significant at 1% level of probability. However data pertaining to each selected district indicated that highest percentage of growth in area under Okra was found in West Champaran i.e. 6.45 per cent followed by East-Champaran (5.63%) and Goharganj *i.e.* about 4.88 per cent. However lowest was estimated in Begusarai (-1.97 per cent) followed by Siwan (-1.38 per cent) and Vaishali (-0.01%) in which negative trend in area was observed but growth in production and productivity were found to be positive and significant in almost all district except for Begusarai (-1.55 per cent) and Siwan (-0.51) in which area was also declined.

However percentage growth in productivity was estimated to be highest in Siwan (2.70%) followed by Patna (2.57 per cent) and Nalanda (2.40 per cent) but lowest growth in productivity was estimated in Gopalganj (-0.40 per cent) in which productivity was declined over period in comparison to other selected district. This clearly indicates that decline in area was mainly due to area shift to *kharif* season cauliflower. It may further be concluded that increase or decrease in area, production and productivity of major vegetable in Bihar over period was mainly due to introduction of new hybrids with good shelf-life having lesser juice of tomato *i.e.* competitive crops of cauliflower by the seed company and potato growers were shifted towards cultivation of cauliflower due to long range of production season available.

Demand supply gap

The per capita demand projection of fruits and vegetable in this study was based on per capita income as a proxy for per capita disposable income due to lack of knowledge on the domestic saving tax structures in the economy in future and various other related factors. Per capita income projection depends on the rate of growth in population and the overall growth in the state. The state income was estimated on the basis of compound growth rate at constant price (1993-94 bases) for the period from 1993 to 2000 and from 2000 to 2010. It was estimated as 3.4 per cent. The value C(0.54 for fruit and 0.90 for vegetable) was estimated on the basis of 66th round of data on consumer expenditure based on information for the period from July 2009-10. It may be observed that the state income of Bihar at constant prices (1993-94) was expected to increase from 5449.65 crores in the year 2001-02 to ₹ 9785.48 crores in the year 2015-20. The per capita rural income for vegetable is expected to increase from 833.65 thousand to 1004.59 thousand rupees (D.R. BAU sabour 2013). On the basis of average per capita consumption of fruit and vegetable in rural and urban sector per capita /day demand of fruits and vegetables was projected for forth coming year i.e. upto 2020 in table 3.

Table 3 depicts the data on per day per capita consumption of fruits and vegetables whatever the rural and urban people of Bihar was actually consuming in 2001-2 and was expected to be increased with same rate.

Table 3: Projected per capita total (rural + urban) demand for fruit in Bihar for the period form 2001-20

Year	Rural/ capita/ gm	Urban/ capita/gm
2001-02	84.00	94.00
2005-06	87.79	98.47
2009-10	94.33	100.50
2010-15	97.77	108.93
2015-20	100.63	112.93

Source: *compiled by the authors.*

In the 2001 it was estimated as 84.00 gm/ capita/ day for fruit (rural area) and for urban areas it was found to be 94.90 gm which was estimated to be increased from 84 gm to 100 gm for rural area and from 94 gm to 112 gm for urban area respectively upto 2020. However, requirement of vegetable and fruit was recommended by the ICMR were about 320 gm and 120 gm respectively. On the basis of recommended requirements of consumption demand for fruits was estimated for the reference period i.e. up to 2031 in table 4.

Table 4: Projected demand, supply and surplus of fruits in Bihar up to 2031 (in '000MT)

Year	Production	Supply	Demand	Surplus
2001-02	2877	2014	3631	-1617
2010-11	3912	2738	4546	-1808
2011-16	4809	3366	5111	-1745
2016-21	5481	3837	5532	-1695
2021-31	6139	4297	6549	-2252

Source: *compiled by the authors.*

The demand and supply projection of major fruits indicated that Bihar as a whole being a deficit state. However, in some selected districts of state has surplus production (D.R. 2013). The demand for fruits in Bihar was 3631 thousand MT in the year 2001 which is expected to increase from 4546 ('000 MT) in 2011 to 6549 ('000 MT) up to 2031. Whereas estimated supply over the period were observed as 2738 ('000 MT) and 4297 ('000 MT) respectively. It clearly indicated the huge gap between supply and demand for fruits over the period mainly because of post-harvest losses (30 per cent of gross production was taken into account).

Therefore greater emphasis is needed on post-harvest management to consolidate the benefits of large potential of fruits in Bihar economy as whole and to nurture a healthy, competitive and vibrant horticulture.

The gap between supply and demand of vegetable indicated that Bihar shall continue to be surplus state over 2031 as shown in the table that difference between demand and supply would likely to be increase in favour of supply i.e., supply was more than demand over the period. Demand of vegetable during the base year was estimated as 9694 lakh metric tones which would likely to increase with decadal growth of population at the rate of 25 per cent along with daily requirement recommended by the ICMR @320 gm/day upto 2031 was estimated as 17464 lakh metric tones where as supply during the same would likely to increased from 6579 to 29978 lakh metric tones respectively.

Table 5: Projected demand and supply of vegetables in Bihar up to 2031 (in lakh MT)

Year	Production	Supply	Demand	Surplus
2001-02	8023	6579	9694	-3115
2010-11	14630	11997	12124	-127
2011-16	23216	19037	13432	5605
2016-21	29246	23981	14757	9224
2021-31	36558	29978	17464	12514

Source: *Compiled by the authors.*

Consumption pattern of fruits and vegetable in Bihar

The expenditure elasticity of vegetable was very high for bottom group consumers of both urban (1.44) and rural areas (1.10). For fruits similar pattern was observed and it was estimated about 1.38 for rural and 1.52 for urban consumers respectively.

Table 6: Expenditure elasticity of demand for vegetable and fruit in Bihar

	Vegetables		Fruits	
	Rural	Urban	Rural	Urban
Bottom	1.10	1.44	1.38	1.52
Middle	0.98	0.96	1.01	0.98
Upper	0.56	0.50	0.80	0.69
Bihar groups	0.88	0.96	1.06	1.06
India groups	0.28	0.30	0.47	0.48

Source: *Compiled by the authors.*

For upper class the expenditure elasticity on fruit and vegetable was comparatively low for both rural and urban areas. Over all the elasticity of fruit in rural area and urban area was estimated to be 1.06. It indicates that in urban area price of fruit does not make any significant difference on demand of fruit for people.

Constraints in Production and Marketing of Major Fruits and Vegetables

The growers of selected villages were confronted with a number of problems related to production and marketing of fruits and vegetables. However, an attempt was made to identify 10 specific marketing and production problems perceived by the growers on the basis of weighted mean average by assigning to each constraint according to preference given by the individual groups of farmers. It revealed that, despite of having strong base of production of vegetable due to high cost of marketing, packaging materials, excessive deduction by trader, problems of transportation means, discomfort in Mandy, low bargaining power, lack of information about price and shortage of cooling facility, improper weighing practices, lack of market information, delay in sale , delay in payment and one of the outmost important i.e. lack of effective market regulation in our state, they were not able to export the produce to other state or the country.

However, major constraints identified for production were, lack of fund, lack of suitable variety of fruits and vegetable. Lack of knowledge about agronomical practices. Slow adoption of improved & commercially accepted cultivars & Varieties, insufficient no of plant in orchard, old age orchard, least interference of Govt. towards increasing productivity, i.e. inadequate and untimely subsidy, problems of fruit drop, size of fruit,Poor management. Pest infestation etc. causes declined in the production of major fruit (mango) and vegetables in Bihar. It may further revealed that according to ranking assigned to each constraints low price spread, low bargaining power, lack of market information were identified as the top three constraints in marketing however for production it was given first rank to lack of fund followed by lack of suitable variety of fruits and vegetables adopted by the farmers and poor management at farm level causes decline in area, under fruits in Bihar. Later on it was tested to check the extent of influence of these assigned constraints in decision on production and marketing of these crops in the study area by using Kendall's coefficient of concordance test.

The identified constraints were ranked accordingly and were weighted according to preference given by a group of farmers consisting of 24 farmers in each group irrespective of level of income, and size of holding i.e., total of 10 groups. The Chi-square at n-1 d.f – was estimated as 60.918 and calculated value was 64.38 observed to be greater than Chi-square table value at 1% and 5% level of significance. Indicated major problem of farmers were inadequate knowledge of market information system, and dis-satisfaction from market price of fruits and vegetables & major constraints identified for vegetable marketing were unavailability of cold storage facility; lack of processing plant in the state etc. Where as senile orchard, lack of adequate knowledge of maintenance, unavailability of fund and input were highly significant constraints for production of these crops in the state.

CONCLUSIONS

The compound growth rate of fruits in Bihar indicated that all selected fruit has shown an increasing trend in area, production and productivity except mango. The demand supply projection of major vegetable was estimated to be about 12.12 million tones in 2011 which would be expected to increase about 17.46 million tones by the year of 2031 which is sufficient to meet out the expected population growth by the year of 2031. If this would likely to continue in future, Bihar would be surplus state and would have large potential of such crop to export in other State/Country. The demand and supply projection of major fruits indicated that Bihar as a whole being a deficit state. However, in some selected districts of state has surplus production and supply but it needs greater emphasis on post-harvest management to consolidate the benefits of large potential of fruits and vegetables in Bihar economy as whole and to nurture a healthy, competitive and vibrant horticultures. Data of five major round i.e. 38th, 43t, 50th, 95th and 66th pertaining to the periods of 1983-84, 1988, 1993-94, 1999-2000, 2005-06 and 2009-10 respectively, shown a positive growth in annual per capita expenditure on fruits and vegetables and found to be more in urban areas than in rural areas. Results of the study revealed that vegetables have emerged as an essential commodity recording income elasticity of demand lower than most of non-cereal commodities, while fruits continued to be more elastic. It may further revealed that according to ranking assigned to each constraints low price spread, low bargaining power, lack of market information were identified as the top three constraints in marketing however for production it was given first rank to lack of fund followed by lack of suitable variety of fruits and vegetables adopted by the farmers and poor management at farm level causes decline in area, under fruits in Bihar.

POLICY IMPLICATION

A wide spread increase in consumption of vegetables and fruits was observed across different income groups in both rural and urban area. The relationship between supply and price of major fruits and vegetable indicated that during the peak period price of vegetable fruit was low and during off season the price of any fruits and vegetable was comparatively higher but due to lack of processing plant, storage facility of fruit and vegetable, prospects of trade of these product has been declining in the state. Despite of such strong area, production and productivity base of fruits and vegetables be still not reach up to satisfactory level where we can export it to other state or Country. The study suggested that, vegetable and fruit are now being viewed at market of national importance owing to the fact that these have large export potential, thus, it can be said that efficient domestic marketing system can only promote the export of these crop. In this regard, it is suggested that the importance of post-harvest management for fruit and vegetable trade should not be ignored. New strategies need to be decided to promote adoption of post-harvest technology by the fruit and vegetable growers while preparing them for marketing. The creation of market infrastructure from export point of view such as creation of pre-cooling, cold storage, air cargo, packinghouse etc. may be taken up by the concerted efforts of the Central and State Govt. This calls for greater role on the part of researcher to develop high yielding varieties and to involve better management practices. Efficient post-harvest management through promotion of infrastructure development is another way to increase availability of vegetables and fruits. It was estimated that the state would have a trade surplus in both fruits (Mango and litchi) and vegetables. The policy makers could promote processing of these vegetables and fruits for value addition and also explore export avenues. However, in the long run the emphasis would be on increasing the productivity of vegetable and fruits in the state.

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An Economic Analysis of Paddy Value Chain in Thanjavur District of Tamil Nadu

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ABSTRACT

In view of the economic importance of value addition the present study was taken up in Thanjavur district of Tamil Nadu, India to estimate value chain of paddy. The aim of the study is to identify the existing value chain and create new chain in the study area. Random sampling technique was used to select 60 farmers. The result showed that, the recovery of main and by product during rice milling was 60 per cent of rice, 10 per cent of broken rice, 15 per cent of rice bran, 10 per cent of husk and 5 per cent waste from one tonne of paddy. In value chain for rice production, the share in value addition was 26.42 per cent for rice millers, 0.16 per cent Rice bran crude oil, 0.09 per cent for Rice bran refined oil, 0.05 per cent for traders, 6.41 per cent rice retailers and 0.04 per cent for rice bran refined oil retailers. In value chain for flaked rice industry, the share in value addition was 14.71, 0.28, 0.08, 0.09, 8.04 and 0.08 per cent for Flaked Rice Industry, Rice Bran Crude Oil, Rice Bran Refined Oil, traders, flaked rice retailers and rice bran refined oil retailers in channel respectively. Finally the study concluded that, the value addition in the existing value chain was ₹ 5096 which can be increased to ₹ 9530 through proposed model.

Highlights

- The long marketing channel which includes more intermediaries and less value addition at farmer level results in low profit to the farmers. Developing a good value chain for rice which will benefit all the stake holders in rice value chain is the need of present hour.

Keywords: Value chain, rice, flaked rice, by products of paddy

Rice is one of the most important staple food crops in the world. Over 50 per cent of the world population depends on rice for their 80 per cent of the food requirements. Rice contributes 43 per cent of total food grains production and it provides 21 per cent of global human per capita energy and 15 per cent of per capita protein requirement (source (FAO, 2019). Rice is produced all over the world particularly in South East Asian region, which plays a significant role in both production as well as consumption. According to Food and Agricultural Organization (FAO, 2019), the country's rice area and production were 44 million hectares and 117.47 million tonnes respectively. The average rice productivity in India was found to be 2576 kg per hectare during 2018-19. Major Rice growing states in India are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Bihar, Orissa, Chhattisgarh, Assam and Tamil Nadu. Rice is the most important food crop in Tamil Nadu and it is grown in almost all the districts of the state. In 2017-18, the area under paddy cultivation in Tamil Nadu was 18.91 lakh hectares and the production was 66.38 lakh tones. The productivity of paddy in Tamil Nadu is 3630 kg per hectare. (*Source: Season and Crop Report of Tamil Nadu, Government of Tamil Nadu 2017-18*). The price of paddy is fixed on four major criteria namely moisture content (11-12%), recovery of rice, broken

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rice and black grains. Role of value chain is reducing inventories, wastage, costs and increase efficiency within the firm and market channel. Collaborative planning and information sharing practices will streamline the information flow in the value chain. A good value chain will provide superior value to the ultimate customer (Richard and Besigye, 2005). There are many value added products that is produced from paddy. The major products are Rice, Rice bran oil, Flaked rice, Rice flour, Rice milk, Rice pudding, Rice starch, Rice straw, Rice used in beverage making, Rice paper, Rice glue, Rice cakes (Mochi), Rice vinegar, Rice soy milk, Red yeast rice and other Rice based food products. This study will provide a clear picture on value addition, marketing efficiency etc, in the present rice marketing system. Value addition process and possibilities in each and every stage of marketing of rice from the farmer to consumer will be revealed. The result would help the farmers to cultivate consumer preferred rice varieties using modern technologies. The study would be helpful to the farmers to enhance their income and rice processing industries to manage their value chain effectively by minimizing the cost and increasing the efficiency and thereby enhance their profit. The rationality of value addition on rice, which satisfies the consumer needs, can be identified and the consumers would benefit through the quality product as they prefer. This study will be useful to the farmers and other stakeholders, researchers and policy makers.

Specific Objectives

1. To study the value addition processes in rice.
2. To identify and map the existing rice value chain in Thanjavur district of Tamil Nadu.
3. To develop suitable value chain model and suggest suitable policy measures.

Data and Methodology

Thanjavur district (called as rice bowl of Tamil Nadu) is the major paddy producing district was selected for this study. From the district, two taluks were randomly selected (Thiruvaiyaru and Vallam taluks) and from each taluk three villages were selected at randomly. The farmers were contacted individually for collection of production and marketing details of paddy with the help of well structured and pre - tested interview schedule. The intermediaries involved in marketing of paddy namely village traders, wholesalers, retailers and processors were also interviewed for the study.

RESULTS AND DISCUSSION

General Characteristics of Sample Farmers

It was observed from Table 1 among the 60 sample farmers 45 per cent of farm house holds had medium size family with four to five persons per family, 46.47 per cent of the farmers were in the age group between 40 to 50 years, 73.33 per cent of farmers had only secondary level of education 46.67 per cent farmers had the experience of more than 20 to 30 years. Regarding size of land holding, 45 per cent farmers are small farmers having less than two hectares of land.

Table 1: Socio Economic Characteristics of Sample Farmers

Sl. No.	Particulars	Numbers	Per cent
I	Family Size		
	Small (< 4)	17	28.33
	Medium (4-5)	27	45.00
	Large (>5)	16	26.67
II	Age group (Years)		
	<40	13	21.66
	40-50	28	46.67
	>50	19	31.67
III	**Educational status**		
	Illiterate	3	5.00
	Primary	10	16.67
	Secondary	44	73.33
	Degree	3	5.00
IV	**Experience (Years)**		
	20-30	28	46.67
	31-40	18	30.00
	Above 40	14	23.33
V	**Size of land holdings (ha)**		
	<2 (small)	27	45.00
	2 to 4 (medium)	22	36.67
	>4 (Large)	11	18.33

Cropping Pattern

Cropping pattern observed in sample farms for the year 2016-17 is presented in Table 2. It clearly showed that in the study area major area was under paddy crop i.e. 61.42 per cent. This is mainly due to the environmental and climatic factors that were highly suitable to grow paddy crop. Next to paddy, sugar cane and black gram occupied the major area of 19.72 per cent and 7.94 per cent, respectively. Crops such as groundnut, gingelly, banana, watermelon and green gram were also grown in small areas.

Table 2: Area under Major Crops in Sample Farms during 2016-17

Sl. No.	Crops	Area in hectares	Per cent to the total
1	Paddy	86.60	61.42
2	Sugar cane	27.80	19.72
3	Black gram	11.20	7.94
4	Groundnut	6.40	4.54
5	Banana	3.40	2.41
6	Green gram	3.20	2.27
7	Gingelly	1.20	0.85
8	Watermelon	1.20	0.85
	Total	**141.00**	**100.00**

Value Chain Analysis for Paddy Production

Table 3 shows the average price received by producer for paddy (without any value addition such as drying, storage and etc.) was ₹ 16166. Total cost incurred by rice miller was ₹ 2408 to produce 600 kgs of rice, 150 kgs of bran, 100 kgs broken rice and 100 kgs of husk from paddy. The value addition gained by rice miller was 26.42 per cent.

Rice bran crude oil industry processed 150 kgs of rice bran to produced 12, 83 and 55 kgs of rice bran crude oil, de oiled rice bran (nice) and de oiled rice bran (rough), respectively. The gross return received by rice bran crude oil industry was ₹ 1131. The net value addition gained by rice bran crude oil industry was 0.16 per cent.

The rice bran refined oil industry produced 9.6 kgs of rice bran refined oil, 0.96 kgs of wax and 1.44 soap stock from 12 kgs of rice bran crude oil. The gross return received by rice bran refined oil industry was ₹ 713 and average price paid by trader was ₹ 653. The average price paid by retailer was ₹ 682 and ₹ 22, 200 for rice bran refined oil and rice.

Table 3: Value Chain Analysis of Rice Production (₹/tonne)

Stakeholder	Sources	Purchasing price	Processing/ marketing cost	Output				Gross return	Total cost	Value added	Per cent
				Processed output	Processed output (kg/ tonne of paddy)	Price/ kg	Value				
Farmer										**16166**	**66.84**
Rice miller	Farmer	16166	2408	Rice	600	37	22200	24963	18574	6389	26.42
				Bran	150	6.75	1013				
				Broken rice	100	14	1400				
				Husk	100	3.5	350				
				Waste(chaff)	50	0	0				
RBCO	Rice miller	1013	79	Crude oil	12	47	564	1131	1092	39	0.16
				DORB (nice)	83	4.5	374				
				DORB (rough)	55	3.5	193				
RBRO	RBCO	564	128	Refined oil	9.6	68	653	713	692	21	0.09
				Wax	0.96	15	14				
				Soap Stock	1.44	32	46				
Trader	RBRO	653	17	Refined oil	9.6	71	682	682	670	12	0.05
Retailer	Rice miler	22200	850	Rice	600	41	24600	24600	23050	1550	6.41
	Trader	682	0	Refined oil	9.6	72	691	691	682	9	0.04
Consumer	Rice	24600								**Total (₹) = 24186**	**100**
	RBRO	691									
									Net value addition / tonne of paddy (₹)	**8020**	

Note: RBCO- *Rice Bran Crude Oil,* **RBRO-** *Rice Bran Refined Oil,* **DORB**- *De Oiled Rice Bran.*

Value Chain Analysis for Flaked Rice Production

Table 4 presents the flaked rice processor produced 550 kgs of flaked rice, 240 kgs of bran, 70 kgs of broken rice, 70 kgs of flour and 70 kgs of waste from one tonne of paddy. The total cost incurred by flaked rice processor was ₹ 18,001, which included purchasing price of paddy. Gross return and value addition gained by flaked rice processor were ₹ 20,820 and ₹ 2819 (14.71 per cent) per tonne of paddy respectively. The average price paid by retailers was ₹ 18,150 for 550 kgs of flaked rice.

The rice bran crude oil industry produces 19 kgs, 132 kgs and 89 kgs of rice bran crude oil, de oiled rice bran (nice) and de oiled rice bran (rough) from 240 kgs of bran, respectively. The value addition gained by the rice bran crude oil industry was ₹ 54 with gross return of ₹ 1799. The rice bran refined oil industry produced 15 kgs of rice bran refined oil, 1.6 kgs of soap stock and 2.4 kgs of wax from 19 kgs of rice bran crude oil. The gross return received by rice bran refined oil industry was ₹ 1107 and value addition was ₹ 15 (0.08 per cent) per tonnes of paddy. The average price paid by trader was ₹ 1020 for 15 kgs of rice bran refined oil. The average price paid by retailer was ₹ 1065 for rice bran refined oil.

Main and By Products of Per Tonne Paddy

Table 5 shows the recovery of main and by products of paddy having various processing process. The recovery of main and by product during rice milling was 60 per cent of rice, 10 per cent of broken rice, 15 per cent of rice bran, 10 per cent of husk and 5 per cent waste from one tonne of paddy. The consumers of rice millers were wholesaler, retailer, ready to cook food manufactures and rice bran crude oil industries. From 15 per cent of rice bran, the rice bran crude oil industry produces 2 per cent of rice bran crude oil and 13 per cent de oiled rice bran. The consumers of rice bran crude oil industry were rice bran refined oil industry, cattle feed industry, poultry feed industry and animal feed

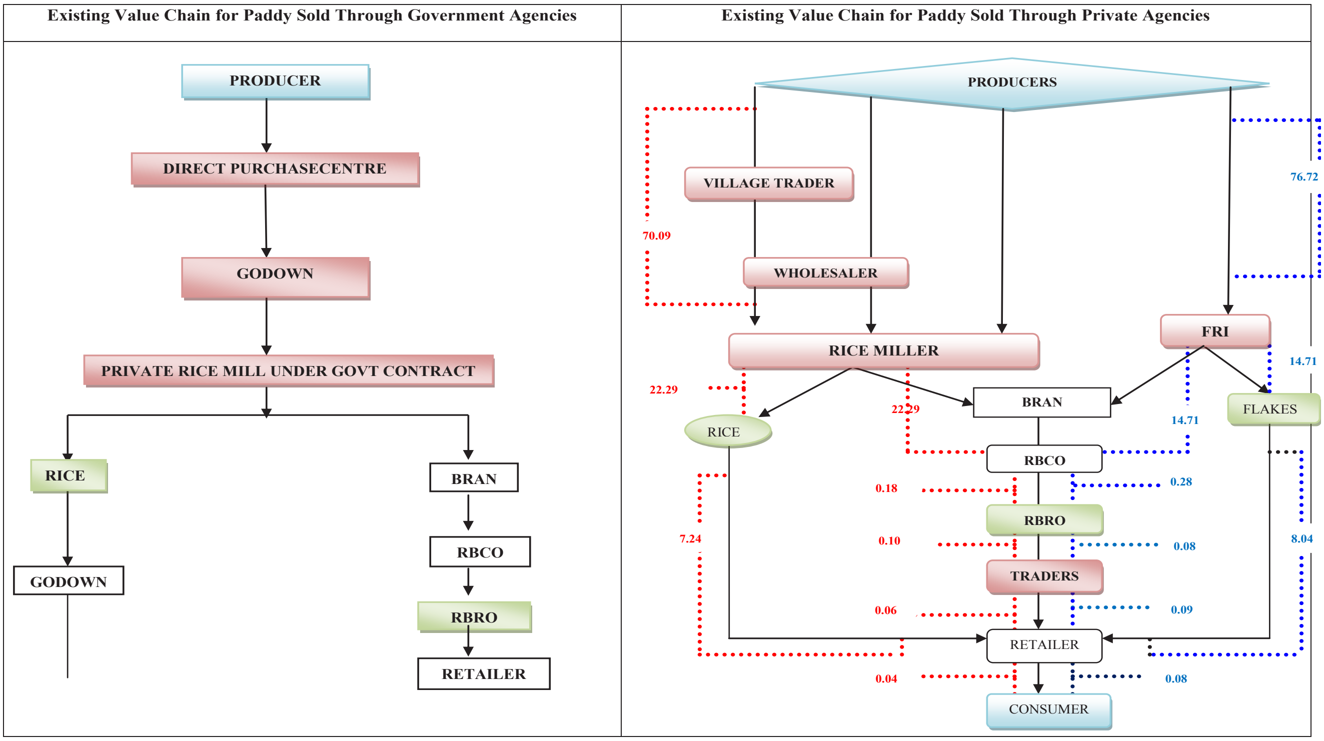
Table 4: Value Chain Analysis of Flaked Rice Production (₹/tonnes)

Stakeholder	Sources	Purchasing price	Processing cost	Output				Gross Return	Total cost	Value added	Per cent
				Processed output	Processed output (kg/tonne of paddy)	Price/ kg	Value				
Farmer										14700	76.72
FRI	Farmer	14700	3301	Flakes	550	33	18150	20820	18001	2819	14.71
				Bran	240	6.75	1620				
				Broken rice	70	8	560				
				Flour	70	7	490				
				Waste(chaff)	70	0	0				
RBCO	FRI	1620	125	Crude oil	19	47	893	1799	1745	54	0.28
				DORB (nice)	132	4.5	594				
				DORB (rough)	89	3.5	312				
RBRO	RBCO	893	199	Refined oil	15	68	1020	1107	1092	15	0.08
				Wax	2.4	15	36				
				Soap Stock	1.6	32	51.2				
Trader	RBRO	1020	27	Refined oil	15	71	1065	1065	1047	18	0.09
Retailer	FRI	18150	660	Flakes	550	37	20350	20350	18810	1540	8.04
	Trader	1065	0	Refined oil	15	72	1080	1080	1065	15	0.08
Consumer	Flaked rice	20350									
	RBRO	1080									
Total (₹)										**19161**	**100.00**
Net value addition / tonne of paddy (₹)										**4461**	

Note: RBCO- *Rice Bran Crude Oil,* **RBRO-** *Rice Bran Refined Oil,* **DORB**- *De Oiled Rice Bran,* **FRI-** *Flaked Rice Industry.*

Table 5: Summary of the Main and by Products from one tone paddy in the Study Area

Portfolio of product	Recovery of paddy	Processing unit	Processors / Consumer
Main product of paddy from rice milling			
Rice	60 per cent of paddy	Rice mills	Wholesaler Retailers Consumers
Broken rice	10 per cent of paddy	Rice mills	Wholesaler Retailers Packaged ready to eat food manufactures
By-products of paddy from Rice Milling			
Husk	10 per cent of paddy	Rice mills	Owned by rice miller used boiler purpose
Rice Bran	15 per cent of paddy	Rice mills	
Wastage	5 per cent of paddy	Rice mills	Rice bran crude oil industry
Main product from rice bran crude oil industry (per tonne of rice bran)			
Rice bran crude oil	2 per cent of rice bran	Rice bran crude oil industry	Rice bran refined oil industry
By Product from rice bran crude oil industry			
De- oiled rice bran	13 per cent of rice bran	Rice bran crude oil industry	Animal feed industry Cattle feed industry Poultry feed industry
Main Product from rice bran refined oil industry			
Rice bran refined oil	1.8 per cent of rice bran crude oil	Rice bran refined oil industry	Traders Retailers
By Product from rice bran refined oil industry			
Soap Stock / Acid Oil	0.12 per cent of Rice bran crude oil	Rice bran refined oil industry	Soap Industries
Wax	0.08 per cent of Rice bran	Rice bran refined oil industry	Paper Industry Textile industry


Existing Value Chain for Paddy Sold Through Government Agencies

Existing Value Chain for Paddy Sold Through Private Agencies

Note: *…….. Value chain for unbranded ADT 37 paddy variety and …….Value chain for flaked rice industry.*

Note: *RBCO- Rice Bran Crude Oil Industry, RBRO- Rice Bran Refined Oil Industry, FRI- Flaked Rice Industry*

Fig. 1: Existing Value Chain Map in the Study Area

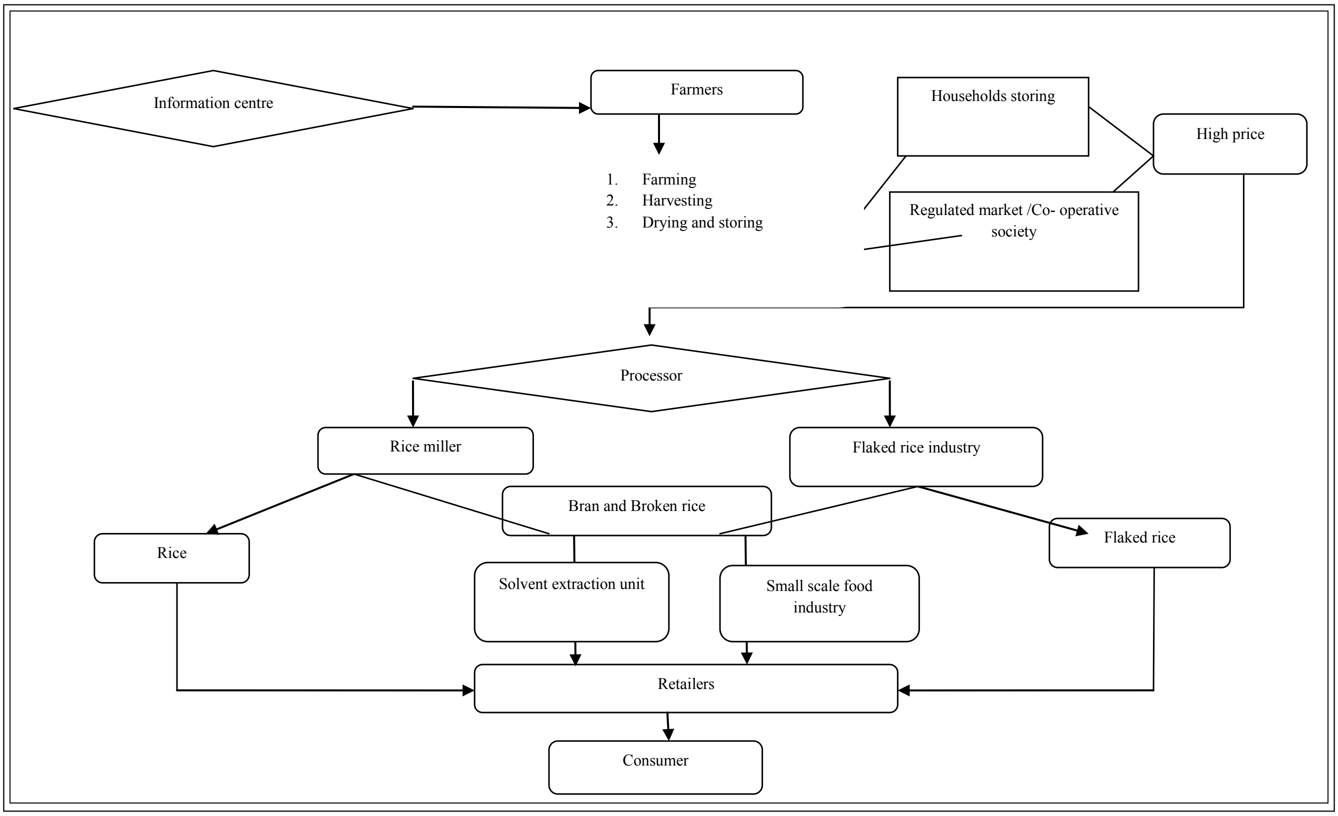


Fig. 2: Proposed Value Chain for Paddy in the Study Area

industries. Rice bran refined oil industry produced 1.8 per cent of rice bran refined oil, 0.08 per cent of wax and remaining 0.12 per cent was soap/ stock or acid oil from one tonne of rice bran crude oil. The consumers of rice bran oil industry were soap manufacturers, traders, retailer, paper industry, textile industry.

Proposed Value Chain for Paddy in the Study Area

The new value chain model emerged out of the study is presented in the Fig. 2. In the model various aspect of rice marketing, processing, value addition etc, was incorporated to add maximum value to the paddy and enhance the consumer satisfaction. In the model various stake holders from farmers to ultimate consumers were taking part. At each and every stage of paddy value chain value will be added in the model.

Advantages of Proposed Value Chain Model Over Existing Value Chain Model of Paddy

The cost and returns of existing and proposed value chain model is presented in Table 6. In comparison with the existing value chain in the proposed value chain model the village traders and wholesalers were eliminated. In rice milling due to increase in the recovery percentage the net value addition will be increased from ₹ 4064 in existing model to ₹ 6115 in proposed model. At present there are two processing industries for rice bran oil production such as rice bran crude oil industry and rice bran refined oil industry. If one solvent extraction plant is used for this purpose the value addition can be increased manifold from ₹ 39 to ₹ 665 through solvent extraction plant. There was no small scale industry for processing the byproduct such as broken rice in the existing model. But in case of proposed model the small scale industries give additional value addition of ₹ 410 per tonne of paddy. The value addition at retailer stage prices have increased from ₹ 950 for rice in existing model to ₹ 1220 in proposed model followed by rice bran refined oil value addition which can be enhanced from ₹ 9 to ₹ 40. Additionally the retailing value addition through ready to cook products will be added as extra to the worth of ₹ 80. To summarize the value addition in the existing value chain which was ₹ 5096 can be increase to ₹ 9530 through proposed model. Through the proposed model the

Table 6: Cost and return of existing and proposed value chain in paddy

Existing value model in the study area

Value chain participants	**Farmers**	**Village trader**	**Wholesaler**	**Rice millers**	**RBCO**	**RBRO**	**Small scale industry**	**Trader**	**Retailers**
Value addition practices	Nil	Nil	Nil	Milling	Processing	Processing	Nil	Nil	Nil
Produce commodity	Paddy	Paddy	Paddy	Rice	RBCO	RBRO	Nil	RBRO	Rice RBRO
Gross return	14000	14780	15490	24963	1131	713	—	682	21000 (Rice) 691 (RBRO)
Total cost	—	—	—	17898	1092	692	—	670	20050 (Rice) 682 (RBRO)
Value addition	—	—	—	4065	39	21	—	12	950 (Rice) 9 (RBRO)
								Total value addition / tonne of paddy (₹)	**5096**

Proposed value chain model in the study area

Value chain participants	**Farmers**	**Nil**	**Nil**	**Rice millers**	**Solvent extraction plant**	**Nil**	**Small scale industry**	**Nil**	**Retailers**
Value addition practices	Knowledge gained from information centre, Storage, Maintain Moisture content	Nil	Nil	Milling	Processing	Nil	Processing	Nil	Nil
Produce commodity	Paddy	Nil	Nil	Rice	RBRO	Nil	RTC products	Nil	Rice RBRO
Gross return	16000	Nil	Nil	24390	1814	Nil	3020	Nil	24150 (Rice) 720 (RBRO) 3200 (RTC)
Total cost	15000	Nil	Nil	18275	1149	Nil	2610	Nil	22930 (Rice) 680 (RBRO) 3120 (RTC)
Value addition	1000	Nil	Nil	6115	665	Nil	410	Nil	1220 (Rice) 40 (RBRO) 80 (RTC)
								Total value addition / tonne of paddy (₹)	**9530**

Note: RBCO, *Rice Bran Crude oil,* **RBRO,** *Rice Bran Refined Oil,* **RTC,** *Ready to Cook products.*

value addition can be increased to the extent of 91.5 per cent.

CONCLUSION AND POLICY IMPLICATIONS

In value chain for rice production, the share in value addition was 26.42 per cent for rice millers, 0.16 per cent for RBCO, 0.09 per cent for RBRO, 0.05 for traders, 6.41 rice retailers and 0.04 per cent for rice bran refined oil retailers. In value chain for flaked rice industry, the share in value addition was 14.71, 0.28, 0.08, 0.09, 8.04 and 0.08 per cent for FRI, RBCO, RBRO, traders, flaked rice retailers and rice bran refined oil retailers in channel. However, the study revealed the possibilities of enhanced rice value chain, where the value addition can be enhanced from existing value addition of ₹ 5096 to ₹ 9530 per tonne of paddy through the proposed value chain model that will benefit all the stake holders of paddy value chain in the study area.

Policy Implications

The general value chain followed in the study districts reveals that, there is no much value addition at the farm level. In reality the value addition process begins from the rice miller, it has to be initiated from farm level like, production of high value rice variety, drying, storing etc, to increase the income of the rice farmers.

Value chain analysis is an effective source for market information. The information on the quality, variety, consumer preference etc, obtained from value chain studies has to reach all value chain actors to increase the benefits and efficiency of all stakeholders in rice value chain.

Quality is always important factor for preference of branded rice. Since the consumer are more health conscious, the rice millers have to focus on the quality aspect (such as less broken and policing) etc, to fulfill the consumer expectation.

Nowadays people are more health conscious and the consumers felt that rice bran oil is highly beneficial in day-to-day life. Hence there is need of more thrust and advertisement on the health benefit aspects of rice bran oil to attract more consumers, this will help the processors to scale up their production, in turn the cost of production would be reduced.

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Regional Optimal Crop Planning for Sustainability in North-Eastern Dry Zone of Karnataka

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ABSTRACT

This study is aimed at designing the sustainable regional crop planning for North-Eastern Dry Zone (NEDZ) of Karnataka. The extent of efficiency in resource use and allocation as reflected in the costs incurred and net returns realized by valuing inputs at market prices, economic prices, natural resource valuation technique (NRVT) are quantified for Manvi and Raichur taluks of Raichur district in NEDZ of Karnataka. A random sample of 30 farmers each under rainfed condition, borewell irrigation and canal irrigation are studied. The study shows that optimal crop plan under market prices, it is not profitable to cultivate cotton under both canal and borewell irrigation. The area allocated to cotton under borewell condition instead of paddy when economic pricing was considered. This is due to less water requirement in cotton (49.4 acre inches per ha) than paddy (98.8 acre inches per ha).The area allocated for rainfed Redgram is higher in NRVT (69956 ha) than at economic price and market prices (31072 ha). This is due to higher net returns realized due to nitrogen fixation. Sustainable optimal crop plan for the region developed using linear programming technique indicated that, 168293 ha is to be allocated in canal, 457328 ha for rainfed, but no area allocated for borewell irrigated condition. Total optimum area allocated was 625621 ha which maximized net return to ₹ 1185 crores for Raichur District in the NEDZ of Karnataka. Crops cultivated under borewell condition were not profitable and sustainable because of higher cost of groundwater and also environmentally unproductive by looking into NRVT with water cost.

Highlights

- Policy makers can make use of the optimum regional crop plan developed to restrict the production of output which faces the problem of recurrent production and over production through support schemes and other fiscal incentives and disincentives.
- The developed optimum region crop plan also helps to optimum and sustainable use of resources and which improves the quality life of farmers.

Keywords: Optimal crop planning, market & economic prices, natural resources valuation techniques, sustainability

Crop area allocated to different crops by farmers depends upon, *inter alia* market forces for specific crops dictated by road, rail, vehicular infrastructure, rural-urban influence, availability of water resource, especially groundwater, availability of electricity for pumping groundwater, on farm endowments of the farmers, degree of awareness and exposure to agricultural technology, access to credit and information, extent of rainfall, temperature and other climatic factors, extent of subsidies received and used. However, the extent to which the principle of comparative advantage determines or dictates the crop pattern and land use is an economic puzzle. While agro climatic, socio economic, and biophysical factors rule the cropping pattern, the extent of technical, allocative and economic inefficiencies

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differ depending upon the crop, region, farmers, access to irrigation and other factors. There are no compelling reasons to accept that prima facie there is efficiency across all farmers and all crops.

Due to market price distortions influenced by the extent of subsidies offered to fertilizer, water, credit, and other inputs, price support offered to food crops, the efficiency of crop pattern and resource allocation is bound to be affected. On the other hand, subsidies for vital inputs are also required in order that the area / region / country do not suffer from food insecurity. However, food and livelihood security should not be at the cost of inefficiency in resource use, resource allocation, loss of efficiency, indiscriminate use of natural resources such as land, water and environment affecting sustainability. Again, this does not imply that there is gross inefficiency in allocation of all the resources and that addressing market imperfections alone is a panacea for all the economic illnesses faced by the farmers. This study is aimed at exploring the profitability of crops in Karnataka in general and in North-Eastern Dry Zone of Karnataka in particular in order to estimate the extent of inefficiency in resource use and allocation as reflected in the costs incurred and net returns realized valuing the inputs at market prices, economic prices, natural resource values such as fixation of atmospheric nitrogen and liberation of greenhouse gases, as well as costing or valuing water resource in general and groundwater resource in particular. The role of subsidies, price support to different crops, Governmental support to different regions / States played and is still playing a crucial and vital role addressing food security concerns. Due to these factors, currently India does not face the food shortage. The question of starvation death which was prevalent during the times of acute food shortage is now in oblivion. Thus, India did emphasize on augmenting food production through incentivizing farmers. The farmers in the country rapidly responded to this call and facilitated the Government to overcome food shortages and currently India is a reasonable position with respect to food. Thus, during the green revolution and immediate post green revolution periods, result oriented strategy towards quick growth in production took the stage and became more important than agro economic factors, suitability and natural resource endowments. Thus, crop pattern changes and crop shifts in 1970's served the social objective and in the process, the principle of efficiency and comparative advantage are sacrificed to some extent. With the result, Punjab now cultivates rice crop while rice was being cultivated in regions of hot climate coupled with canal water availability. Thus, rice has spread in such areas where it was never found earlier. Similarly, sugarcane is being cultivated in areas where surface water is not abundant, but groundwater is extracted to cultivate sugarcane. These indicate that the market distortions influenced by subsidies and price support offer non-natural advantages to cultivate different crops in different periods. Obviously these crops were never grown earlier as the agro-climatic factors did not facilitate them, resulting in expensive ways of cultivating crops. The cost of cultivation of different crops and the returns realizable have also been influenced by non-market forces affecting the natural crop choice by farmers. The extent to which such crop choices are sustainable is a serious economic question and puzzle.

Due to crop choices which are natural resource intensive, it is in order to examine whether cultivation of such crops is equitable and sustainable. These are affecting the profitability of crops which in turn result in economically irrational crop choices, crop mixtures and enterprise combinations. Farmers are also finding it extremely difficult to sustain such input incentive crop pattern. An important economic reason for farmers' crop choice is also that the cost of vital input like surface water and groundwater is ignored / discounted, with the result that farmers while they incur investment on water, the expenditure is not taken into account in the cost of cultivation of crops. The present practices by farmers clearly demonstrate that the choice of crop pattern and cost of cultivation are subjective, lacking economic rationale. The extent of land degradation, secular overdraft of aquifers, negative externalities, are prima facie indicators of farmers' economically irrational behavior in agriculture. Accordingly it is in order that farmers are given information so that they would consider them to guide their crop planning and management in order that their actions are consistent with natural resource conservation, endowment so that they reach allocative, technical and economic efficiency including sustainability. Natural resource management for equity and sustainability is crucial for small and marginal farmers as their resource base is shrinking over years. Farm management is a crucial aspect for managing different natural resources. Thus, this underscores the importance of allocation of resources and distribution of crops considering sustainability and resource use efficiency. The overall impact of natural resource management with sustainability needs to reflect on the optimal crop pattern in consonance with natural resource availability along with resource endowments of farmers. Thus, this study is aimed at development of optimal crop plan with resource use efficiency and sustainability for North-Eastern Dry Agro-climatic Zone (NEDAZ) of Karnataka with the following specific objectives.

MATERIALS AND METHODS

Raichur district has been chosen in North-Eastern Dry Zone of Karnataka (NEDZ) for field work in two taluks namely Raichur and Manvi. The Random sampling method was adopted for the selection of sample farmers. Data were collected from 30 rainfed farmers, 30 farmers who are using groundwater and 30 farmers who are using canal irrigation. Thus total sample size comprised of 90 farmers. The farmers using underground water for irrigation was identified based on the criteria that 50 per cent of the total cultivated area was irrigated through underground water. Similar classification was made for the selection of the canal irrigated farmer where in which 50 per cent of irrigated area under total cultivated area is through canal irrigation. Likewise the rainfed farmers were identified if the cultivated area with no source of irrigation is more than 50 per cent of the total cultivated land. Simple tabular analysis technique was used to estimate cost and returns of crops in the North Eastern Dry Zone of Karnataka.

Linear programming

In linear programming analysis, linear function of a number of variables (objective function) is maximized (or minimized) subjected to number of constraints in the form of linear equalities or in-equalities. In the present study it was employed to develop the optimum regional crop plan.

Selection of the typical farm

The average area under different crop (ha), labour utilization (man-days), water applied to crops (acre inch), capital expenditure (₹) excluding labour cost incurred and net returns realized by farmers with different sources of irrigation (canal and borewell) and rainfed were calculated, averaged and used for development of the optimum regional crop plan. The computational procedure is as follows:

Mathematical formulation of model

In mathematical form one year linear program can be expressed in the following way.

Maximize $Z = \sum_{i=1}^{n} N_i X_i$ for i=1, 2, 3, 4 ….N is the number of crops

Subject to the constraints,

1. $\sum_{i=1}^{n} W_i X_i \leq W_u \; (i = 1, 2, 3, 4 \ldots N)$
2. $\sum_{i=1}^{n} X_i \leq I \; (i = 1, 2, 3, 4 \ldots\ldots N)$
3. $\sum_{i=1}^{n} X_i \leq R \; (i = 1, 2, 3, 4 \ldots\ldots N)$
4. $\sum_{i=1}^{n} X_i \leq C \; (i = 1, 2, 3, 4 \ldots\ldots N)$
5. $\sum_{i=1}^{n} X_i \geq F_i \; (i = 1, 2, 3, 4 \ldots\ldots N)$
6. $\sum_{i=1}^{n} D_i X_i \leq L \; (i = 1, 2, 3, 4 \ldots\ldots N)$
7. $\sum_{i=1}^{n} T_i X_i \leq B \; (i = 1, 2, 3, 4 \ldots\ldots N)$
8. $X_i \geq 0$

Where,

Z = Total net return (₹) from all crops grown by the farmer in region,

N_i = Net return from the i^{th} crop (₹/ha),

X_i = Crop area under i^{th} crop (ha) (decision variable)

W_i =Water requirement for i^{th} crop (ha cm)

W_u = Total ground water availability (ha cm)

I = Borewell area availability for cultivation in the region

R = Rainfed area availability for cultivation in the region

C = Canal area availability for cultivation in the region

F_i = Food requirement of i^{th} crop in terms of area (ha)

D_i = Labour requirement for i^{th} crop (man-days/ha)

L = Total Agricultural labour availability per year in the region (District)

T_i = Total cost required to produce i^{th} crop (₹/ha)

B = Total budget availability of the farmer in the region (₹) or total cost of production per hectare of all crops multiplied with area under all crops.

Objective function

Objective function was to maximize aggregate net income from crops grown in the farm. The objective function was subject to linearity or non-negativity constraints which are presented above.

Resource level and constraints

Ground water availability

The total ground water availability for Raichur district was taken from the central ground water board as equal to 55760 ha meters which was converted to acre inch by taking conversion factor 1 hectare meter = 97.28 acre inch which is equal to 5424332.8 acre inch per year for the district.

Land area

Land Area Availability and Utilization: Land is one of the limiting resources on all farm situations. It is defined as operational area, which was equal to owned-land plus leased-in land minus leased-out land. The average size of operational holding was 5.12 ha (rainfed farmers), 2.72 ha (borewell farmers) and 4.88 ha (canal farmers), totally the average size of operational land was 4.2 ha as from the data collected. The total area under rainfed in Raichur district was 405300 ha and with 168293 ha was the area under canal irrigation were taken as constraints for rainfed and canal irrigated crops respectively. Area under borewell irrigation was 11526 ha which was taken as limited, constraints for borewell irrigated crops cultivated in the district.

Food production

To fulfil the demand for grains and pulse to the increasing population, the paddy, redgram, Chickpea were taken as constraints equal to or more than the existing area under crop in the last year from DES data. Similarly sorghum as fodder to feed livestock was considered.

Agricultural labour availability

The labour availability for agriculture work was 269528 man days as per the district data 2011, multiplied with 180 days (Average working days of agricultural labour per year). The final agricultural labour availability was 48515040 days per year.

Working Capital /Budget availability

To calculate capital use on the farm, the costs of seed, manures, fertilizers, pesticides, insecticides, hiring of bullocks and machinery, irrigation charges, etc. were added up and the cash requirements for rainfed, borewell, canal crops were worked out separately. For estimating capital availability on the farm, it was assumed that the expenditure incurred on variable inputs was taken as per data collected from sample farmers from the respective crops and multiplied with the existing area of sample data which gives total capital availability to the entire district was 1026.87 Crore.

Non-negativity constraints:

The variables in the linear programs were must be greater than or equal to zero which should not be negative returns or inputs.

RESULTS AND DISCUSSION

Regional crop planning taking market prices, economic pricing and NRVT with water cost of input and output in to consideration.

The major crops cultivated in Raichur district and the constraints were subjected to linear programming in order to obtain the economic optimum cropping plan at market prices, economic prices and natural resource valuation including costing groundwater for irrigation. The area under paddy, redgram, and chickpea is fixed to meet the food requirements for the increasing population whereas Sorghum as fodder for the livestock as per the area under previous year from DES. The results presented in the Table 1 indicated that when market prices are considered, the optimal area allocated under canal irrigation is 1.6 lakh ha, while allocating 4.25 lakh ha under rainfed crops. The optimal crop plan suggested making use of 11 lakh ha cm of groundwater out of 54 lakh ha cm, 343 lakh man days of labour out of 485 lakh man days of labour.

Table 1: Regional crop planning for Raichur District considering inputs and outputs at market prices, economic prices and NRVT approaches

Particulars	**Allocated resources**			**Constraints Specification**	
	Market prices	**Economic prices**	**NRVT with water cost**		
Canal irrigated area (ha)	168293	168293	168293	≤	168293
Borewell irrigated area (ha)	11526	11526	0	≤	11526
Rainfed area (ha)	425035	429150	457328	≥	405300
Capital cost (crores)	1026.87	1026.87	1026.87	≤	1026.87
Ground water Availability(Acre inches)	1138768.8	570191.22	0	≤	5424332.8
Total agricultural labour availability (Man-days)	34373599	34742222	34715876	≤	48515040
Paddy (ha)	179819	168293	168293	≥	151707
Redgram (ha)	31072	31072	69956	≥	31072
Chickpea (ha)	109636	109636	109636	≥	109636
Sorghum (ha)	109203	109203	109203	≥	109203
Total area allocated ha	604854	608969	625621	≤	625621
Net return (Crores)	1500.50	1249.20	1185.78		

***Note* 1**: *NRMP (Net returns based on market prices) = Gross Income minus (Cost A_2+ IVFL); NREP (Net returns based on economic prices) = NRMP minus (Fertilizer subsidy + Electricity subsidy), NRNRVT without water cost (Net returns based on Natural resource valuation technique without water cost) = NREP + Nitrogen fixation value – GHS emission cost. NRNRVT with water cost (Net returns based on Natural resource valuation technique without water cost) = NREP + Nitrogen fixation value – GHS emission cost-water cost;* **2**: *Energy subsidy for canal irrigated crops ₹ 100 per acre of paddy, and ₹ 35 per acre for semi-arid crops;* **3**. *Energy subsidy for borewell irrigated crops same as that of energy cost of pumping = working hours of Irrigation pumpset * Horse power of the Irrigation pumpset * 0.75 KWH * ₹ 3.5 per KWH);* **4**: *Fertilizer subsidy per kg of N_2 = ₹ 20.87; that per kg of P_2O_5 = ₹ 18.67; per kg of K_2O = ₹ 15.50.);* **5**: *GHG cost ₹ 0.463 per kg of CO_2;* **6**: *Surface water cost ₹ 3130 per ha for paddy, ₹ 1095 per ha for semi-arid crops;* **7**: *Groundwater cost ₹ 200 per acre inch water required 40 acre inch for paddy, 20 acre in for cotton, 12 acre inch for groundnut.*

When economic prices are considered, the optimal area allocated under canal irrigation is 1.6 lakh ha, while allocating 4.29 lakh ha under rainfed crops. The optimal crop plan suggested making use of 5.70 lakh ha cm of groundwater out of 54 lakh ha cms, 347 lakh man days of labour out of 485 lakh man days of labour. When natural resource valuation and costing of groundwater are considered the optimal area allocated under canal irrigation is 1.6 lakh ha, while allocating 4.57 lakh ha under rainfed crops. The optimal crop plan suggested without using groundwater out of 54 lakh ha cm, 347 lakh man days of labour out of 485 lakh man days of labour.

The regional crop planning of Raichur district by considering different approaches, results indicated that higher net returns were realized by market prices compared to economic and NRVT with water cost by allocated area of 604854 ha under market prices, 608969 ha under economic prices, entire area under NRVT with water cost of 625621 ha. Area allocated for the paddy cultivation (179819 ha) is more in market prices compared to economic (168293 ha) and NRVT with cost (168293) which is also more than area under constraints (151707 ha). The area allocated in red gram cultivation was increased in NRVT with water cost compared to market prices and economic prices than the constraints area allocated area to redgram cultivation. There is no changes in area allocated for chickpea (109636 ha), sorghum (109203 ha), for markets prices, economic prices and NRVT with water cost. Allocated canal area is same in all three approaches and area under borewell irrigated is not allocated for NRVT with water cost. The area under rainfed cultivation was increased in all approaches than the area under rainfed constraints.

Regional optimum allocated area for crops taking market prices, economic pricing and NRVT with water cost of input and output in to consideration

The results presented in the Table 2, indicated that when market prices are considered, the optimal crop plan included rainfed cotton, sorghum, canal

Table 2: Regional optimum allocated area for Raichur District considering inputs and outputs at Market prices, economic prices and NRVT approaches

Crops	Market prices		Economic prices		NRVT with groundwater cost		Area under crop as per DES (ha)
	Net returns (₹ per ha)	**Optimal area (ha)**	**Net returns (₹ per ha**	**Optimal area (ha)**	**Net returns**	**Optimal area (₹ per ha)**	
Cotton (RF)	24424	175124	20478	179239	20428	168533	53360
Cotton (Canal)	33704	0	28786	0	27612	0	
Cotton (BW)	40442	0	34037	11526	24079	0	
Sorghum (RF)	9088	109203	7602	109203	7575	109203	109203
Paddy (Canal)	44133	168293	36426	168293	31397	168293	151707
Paddy (BW)	49576	11526	38390	0	16731	0	
Redgram (RF)	14375	31072	12161	31072	13205	69956	31072
Chickpea (RF)	11766	109636	9570	109636	12250	109636	109636
Sunflower (RF)	6395	0	3908	0	3866	0	67767
Bajra (RF)	3735	0	1459	0	1431	0	52357
Groundnut (BW)	19782	0	15747	0	10907	0	43532

and borewell irrigated paddy, rainfed redgram and chickpea and excluded canal and borewell irrigated cotton, rainfed sunflower and rainfed Bajra, totaling to 6.04 lakh ha out of 6.25 lakh ha of area..

When economic prices are considered, the optimal crop plan included rainfed and borewell irrigated cotton, rainfed sorghum, canal irrigated paddy, rainfed redgram and chickpea and excluded canal irrigated cotton, borewell irrigated paddy, rainfed sunflower and rainfed Bajra, totaling to 6.08 lakh ha out of 6.25 lakh ha of area. The results indicated that when natural resource valuation and costing of groundwater are considered, the optimal crop plan included rainfed cotton and sorghum, canal irrigated paddy, rainfed redgram, rainfed chickpea and excluded canal and borewell irrigated cotton, borewell irrigated paddy and borewell irrigated groundnut, rainfed sunflower and Bajra, totaling to 6.25 lakh ha out of 6.25 lakh ha of area. The highest area was allocated to cotton (175124 ha) under rainfed situation compared to sorghum, redgram, chickpea, sorghum when considered in all three approaches. The canal irrigated area is allocated by only paddy crop rather than cotton because of higher net return realized by farmers. Area allocated to paddy with canal situation is same in three approaches. The changes were found in area allocated with groundwater condition, in case of market prices area allocated to the cotton, in case of economic prices area allocated to the paddy and no area allocated to any crops when considering NRVT with water cost.

CONCLUSIONS

Regional optimum crop plan for district indicates that there is changes in canal irrigated area in all three approaches like net returns realized by economic prices, net returns realized by economic prices and net returns realized by natural resources valuation. The area under borewell irrigation is allocated by looking into market and economic approaches only. The area approach didn't look into NRVT with water cost which indicates that the crops were grown in borewell condition. The NRVT with water cost is not so profitable under borewell irrigated area because of higher ground water cost and also unsustainable. The area allocated to rainfed condition has increased in NRVT with water cost and economic price when compared to market price. This is because of environmentally safe nature of pulses, higher net returns were realized by nitrogen fixation.

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Incidence and Determinants of Indebtedness of Agricultural Households in Gujarat

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ABSTRACT

Amidst the scenario of distress among agrarian community it is very important to discuss farmers indebtedness. Most of the studies in India revealed that indebtedness of farm households is one of the crucial factors responsible for crisis. This paper examines the nature and determinants of farmer's indebtedness using unit record data from NSSO 70th round in Gujarat state. Incidence of indebtedness was studied using tabular and percentage analysis, while determinants were assessed using binomial logistic regression model. It was found that, the incidence of indebtedness was higher in agricultural households with large land holding size as compare to their counterparts with less land holding. Incidence was higher in non-SC/ST households than that of SC/ST households. There is ample scope for financial inclusion in South Eastern region of the state as non-institutional sources of credit were found more active. Households having cultivation as primary source of income were more likely to be indebted. MGNREGA job card holders also found more likely to become indebted. Thus, government should interfere in order to make hassle-free credit availability to the marginalized farm households for their livelihood security in the state.

Highlights

- The present study made efforts to evaluate the incidence of indebtedness among various categories of agricultural households in order to bring in light the comparison in financial obligations among them. It may help the policymakers to relook in the credit advancement policies to make it better.

Keywords: Incidence of indebtedness, financial inclusion, institutional credit, marginalised farmer.

It has considerable importance in the discussion of the issues of farmers indebtedness. There is continuous credit needs by farmer for meeting there working capital needs. Hence timely and affordable credit provision to farm households plays crucial role in the betterment of agrarian community. Most of the studies shows that marginal and resource poor farmers have not much access to the formal credit network (Swain, 2001; Swain and Swain, 2007). Thus,in policy perspectives it is important to know the status of access to formal as well as informal credit system among various groups of farm households and farmer's financial commitments in long as well as short term periods. In this context, variation in regional estimates have also importance as resource distribution in various regions of different states is uneven and leads to distress. Economic status of the farm household is bettered reflected through the size of land holding rather than income or expenditure. Considering the same aspect, we examine incidence of indebtedness of farm households among various categories

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of land holding size. The evaluation also made among different social groups and primary source of income of farm households. Attempt was also made to study the probable factors responsible for indebtedness status of farm households.

The present study focused on various NSS regions of Gujarat state where regional disparities in resource distribution, per capita total expenditure and poverty is very high (Dubey, 2009). There are very limited studies performed in indebtedness of farm households particularly in Gujarat state. The study was carried out with dual objectives, first to study the incidence of indebtedness of agricultural households and second is to examine the various determinants that influence the status of agricultural households to be indebted.

METHODOLOGY

Data

The study was based on secondary data available from National Sample Survey Organisation (NSSO) unit level data on *Situation Assessment Survey of Agricultural Households 2012-13* collected under NSSO's 70th Survey Round. Data collected by NSSO focused on rural areas with stratified multistage random sampling and unit of sampling was rural agricultural household. The survey covered 1317 agricultural households in Gujarat in 5 NSS regions. The details of region wise sample and estimated agricultural households is as below:

Analytical tools

Data on incidence of indebtedness among agricultural households with different land holding size, social groups (ST, SC, OBC, Others) and primary source of income was analysed through tabular analysis and percentage approach. Binomial logit model was used to assess various determinant influencing on indebtedness situation of agricultural households. By interacting indebtedness status of household (binary dependent variable, indebted = 1, otherwise = 0) with fixed socio-economic characters of household, it was determined whether different types of households were more or less likely to be indebted.

The logit model estimated was specified as below:

$$\log\left[\frac{P_n}{1-P_n}\right] = R_h = \beta_0 + \beta_1\, LAND + \beta_2\, SQR\_LAND + \beta_3\, AGE + \beta_4\, SQR\_AGE + \beta_5\, HHSZ + \beta_6\, SQR\_HHSZ + \beta_7\, CASTE + \beta_8\, CULTIVATION + \beta_9\, LIVESTK + \beta_{10}\, LIVESTK\_MINOR + \beta_{11}\, MGNREGA + \beta_{12}\, GENDER + \beta_{13}\, EDU + \beta_{14}\, \mathrm{TRAINING} + \varepsilon_h$$

Where, P_n is the probability that a household is indebted, and where, $1–P_n$ is the probability that a household is not indebted. R_h is binary variable for indebtedness status of h^{th} household (yes= 1, No= 0). The set of explanatory variables contain: LAND-operational size of landholding (hectares), AGE - age of the head of the household (years), HHSZ - household size (numbers), CASTE - social group status of household (1 for ST/SC, 0 for Non-SC/ST), CULTIVATION – household having cultivation as primary source of income, LIVESTK - household having livestock as primary source of income, LIVESTK_MINOR – household performing livestock as minor income source, MGNREGA – household having MGNREGA job card (yes = 1, No = 0),

Table 1: Districts covered in NSS regions and sample share from each region

Code	NSS Region	Districts	Estimated nos. of households ('000)	Sample households (nos.)	Sample Share (%)
241	South Eastern	Panch Mahals, Dohad, Vadodara, Narmada, Bharuch, Surat, The Dangs, Navsari, Valsad, Tapi	1484	455	37.8
242	Plains Northern	Mehsana, Sabar Kantha, Gandhinagar, Ahmedabad, Anand, Kheda	919	334	23.4
243	Dry Areas	Bans Kantha, Patan	348	128	8.9
244	Kachchh	Kachchh	156	48	4.0
245	Saurashtra	Surendranagar, Rajkot, Jamnagar, Porbandar, Junagarh, Amreli, Bhavnagar	1021	352	26.0
Gujarat			**3930**	**1317**	**100.0**

GENDER - gender of head of the household (1 for male, 0 otherwise), EDU - educational status of head of the household (1 for not-literate, 0 for literate), TRAINING - Household attended any professional training in agriculture (YES = 1, No = 0) and are logit coefficients and random disturbances, respectively.

The marginal effects were worked out to predict the effect of change in an explanatory variable on the probability of a household becoming indebted.

RESULTS AND DISCUSSION

Incidence of indebtedness (IoI)

The incidence of indebtedness was studied in four sections; firstly, across different land holding size, secondly across household having various primary source of income, thirdly across various social group and lastly across the agencies providing loans to the households (i.e. institutional and non-institutional).

Incidence of indebtedness across different land holding size

An analysis of land size-wise indebtedness (institutional and non-institutional) revealed that the majority of households having land holding less than 2 hectares (68%) are indebted which declines with the increase in the land size that is; 19 per cent on households having land between 2 – 4 hectares, 13 per cent on households having land between 4 - 10 hectares and less than 0.5 per cent on large size of agricultural households in Gujarat. Incidence of indebtedness for marginal households belongs to South eastern region found higher as compare to other regions.

Incidence of indebtedness was more in the regions of Dry areas and Saurashtra as compare to other regions in Gujarat. Incidence was higher for small farners in Plains northern region. Table 2 shows that around 76% of total marginal farmers in South eastern region were indebted which was the highest in all the regions. About 32 % small farmers in Plains northern region found indebted whereas 34 % of total medium farmers in Dry areas region found indebted. Thus, the incidence of indebtedness was higher for marginal and small farmers in all the regions as compare to medium and large land holding categories.

Incidence of indebtedness across household having various primary source of income

Incidence of indebtedness was also studied on the basis of various primary source of income. Table 3 shows that in state as a whole, half of the households having cultivation as a main source of income were indebted. This percentage was quite lower for households having livestock (29%) and non-agri. enterprise (28%) as primary source of income. Almost in all the regions except Plains

Table 2: Percentage of indebted households having different land size class

NSS region	<0.01	0.01-0.40	0.41-1.00	1.01-2.00	2.01-4.00	4.01-10.00	>10.00	All class
South Eastern	0.91	26.90	47.99	12.27	7.07	4.79	0.07	43.2
Plains Northern	8.18	23.54	19.81	32.00	10.21	5.95	0.31	27.1
Dry Areas	5.73	11.28	26.31	15.81	33.81	7.05	0.00	59.5
Kachchh	5.68	0.00	0.00	11.16	9.51	73.65	0.00	28.4
Saurashtra	4.16	1.24	13.84	24.19	32.22	23.35	1.00	52.1
Gujarat	3.75	15.59	28.99	19.40	18.90	12.97	0.39	42.6

Table 3: Percentage of indebted households with different primary source of income

NSS Region	Cultivation	Livestock	Non-agri enterprise	Wage - salary	All Class	Estimated number of indebted households ('000)
South Eastern	48.2	63.2	28.7	33.8	43.2	641
Plains Northern	25.3	23.5	48.5	33	27.1	249
Dry Areas	72.6	19.4	34.4	22.6	59.5	207
Kachchh	51.6	15.8	0	9.4	28.4	44
Saurashtra	68.3	17.4	12.7	34.7	52.1	532
Gujarat	50.5	29.4	28.3	32.3	42.6	1674

northern, half of the agricultural households having cultivation as main income source were found indebted. Incidence is lower for the households having non-agri enterprise and wage – salary as primary source of income in most of the regions.

Incidence of indebtedness acrossvarious social group

An attempt was made to find out incidence of indebtedness among the households belongs to various social groups. Table 4 clearly shows that incidence was higher with non-ST/SC households as compare to ST/SC households. This may exist because of social discrimination in advancement of the loan and thus ST/SC households have less access to the credit. Regional estimates show that incidence was higher for ST households in South eastern region only. Incidence of indebtedness was very low in SC households as compare to all other in all the regions.

Incidence of indebtedness across the agencies providing loans to the households

It was very important to study the incidence of indebtedness on the basis of credit giving agencies in order to know the status of financial inclusion in the state. It was found (table 5) that around 64 % of agricultural households took loan from institutional sources like government, co-operative society and banks in the state. Still 36% loan was granted by non-institutional sources constituting 11% from agricultural and professional money lenders and 9% from shopkeeper and traders. Estimates shows that non-institutional sources are very prominent in South eastern region as around 58% households used them as credit source. This percentage is very low in Kachchh and Saurashtra regions as they depend on institutional credit agencies more than that of non-institutional agencies.

Determinants of indebtedness status

Household's indebtedness status may be an effect of various own socio-economic characters. Here those household having outstanding amount were considered as indented and otherwise as non-indebted. Need of credit may vary with socio-economic characters of household like possession of land, household size, social group status etc. Results of binary logit regression with indebtedness situation as dependent variables are presented in table 6.

It can be seen that, factors like size of total land possession, household size, social group status and household having MGNREGA job card had significant influence on the indebtedness. Other variables were not found significant. Size of land holding had positive influence on the indebtedness of household while its square had negative influence. It means as land size go on increasing, it reduces its positive effect on

Table 4: Percentage of indebted households belongs to different social groups

NSS Region	ST	SC	OBC	Others	Total
South Eastern	39.65	1.66	38.24	20.45	100.00
Plains Northern	0.62	4.57	71.13	23.68	100.00
Dry Areas	13.32	5.53	77.58	3.57	100.00
Kachchh	1.34	4.30	7.69	86.66	100.00
Saurashtra	0.00	2.53	43.86	53.61	100.00
Gujarat	16.97	2.92	48.97	31.14	100.00

Table 5: Percentage of households having various source of loan

NSS region	Government	Co-operative society	Bank	Employer/ landlord	Agricultural/ professional money lender	Shopkeeper/ trader	Relatives/ friends	Total
South Eastern	5.07	13.10	24.69	0.00	19.25	20.30	17.57	100.00
Plains Northern	6.54	29.17	23.37	0.00	11.91	0.58	28.44	100.00
Dry Areas	0.30	34.76	41.08	0.21	8.29	1.57	13.79	100.00
Kachchh	1.95	2.75	86.25	0.00	0.00	5.61	3.44	100.00
Saurashtra	1.70	47.33	40.35	0.00	2.36	0.00	8.25	100.00
Gujarat	3.62	27.91	32.58	0.03	11.43	8.85	15.57	100.00

Table 6: Logit results for factors responsible for indebtedness

Factors	**Coefficient**	**SE**	**ME**
Binary dependent variable	**Household's indebtedness status (Yes – 1, No - 0)**		
LAND (Ha)	0.327***	0.056	0.082
SQR_LAND	-0.009***	0.003	-0.002
AGE (Years)	-0.026	0.029	-0.007
SQR_AGE	0.000	0.000	0.000
HHSZ (Nos)	0.206***	0.076	0.051
SQR_HHSZ	-0.013**	0.005	-0.003
CASTE	-0.710***	0.138	-0.173
CULTIVATION	0.262*	0.149	0.065
LIVESTK	0.025	0.220	0.006
LIVESTK_MINOR	0.106	0.163	0.026
MGNREGA	0.387***	0.145	0.096
GENDER	-0.254	0.246	-0.063
EDU	0.031	0.129	0.008
TRAINING	0.633	0.442	0.155
Constant	-0.636	0.783	
Hosmer and Lemeshow test sig.	0.209		
Pseudo R^2	0.124		

*Level of significance: ***1%, **5% and *10% SE = Standard error ME = Marginal effects.*

indebtedness situation. This may be because credit requirement beyond a certain limit is no more needed. Similarly, household size also has positive association with indebtedness situation as it shows more credit requirement to feed more members of the family. Negative relation of squared household size shows as members increases it may reduce the positive effect of household size in indebtedness. Estimates for social groups status shows that being ST/SC household reduce the likelihood of being indebted. It may because less access to credit system to the households. Households having MGNREGA job card had positive significance on indebtedness status. It shows the inability to pay off loans in time by the poor households bearing job cards.

In addition to this, table 6 also presents marginal effects (ME) of the variables which tell us that how changes in specific variables affect the probabilities of households reacting positively or negatively towards the indebtedness status. Marginal effects computed for continuous variables are not comparable with binary variables.

It shows that, increase a unit in total land possession may increase the probability of being indebted by 8% points. Similarly, a unit increase in household size may increase likelihood of being indebted by 5% points. The very influential factor found was social group status as it shows a unit increase in may reduce the chances of being indebted by 17% points. Further, if a household has MGNREGA job card, it may lower its chances of indebtedness by 9% points.

CONCLUSION

Results of incidence of indebtedness show that the agricultural households having large land holding size were more indebted as compare to their counterparts with less land holding. This may be because of the less access to the credit facility to marginal and small farmers in the state. Higher incidence with non-ST/SC households than ST/SC households shows that there is need of hassle-free availability of credit facility to ST/SC households in the state. Regional analysis shows that non-institutional sources had major role in advancement of credit in South Eastern region. It shows lack of financial inclusion in the region. MGNREGA, which is the assured employment generating programme at national level still have scope to improve the functioning in the state in sake of livelihood security of the marginalized farm households. Policy makers should concentrate on formation of policies enabling marginal and small farmers with better credit access and availability in all the regions of Gujarat.

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AESSRA

Variability and Growth in Production of Wheat in India

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ABSTRACT

Wheat is one of the most popular staple foods in India which compete well with other cereal in nutritive value. Hence based on importance of the crop, the present study examined the performance of wheat production in the country in terms of variability and growth using secondary data for the period of 2000-01 to 2017-18. Variability of wheat in the area, production and productivity was found to be 6.81, 13.87 and 8.10 per cent, respectively for India. The results showed that maximum relative change in area, production and productivity of wheat was noticed in Madhya Pradesh state with 65.97, 226.32 and 96.62 per cent, respectively. Growth in area, production and productivity of wheat crop in India has been increased with positive and highly significant rate of 1.21, 2.46 and 1.23 per cent per annum, respectively. Madhya Pradesh showed highly significant compound growth rates in area, production and productivity with 3.49, 8.21 and 4.56 per cent per annum, respectively. The highest growth in area, production and productivity of wheat in Madhya Pradesh helps in confirming Krishi Karman Award for last five consecutive years. Decomposition analysis indicated that yield contribution in the production of wheat in India was positive and significant with 47.3 per cent followed by area effect of 44.38 per cent whereas interaction effect was found to be 8.31 per cent only revealing that increased productivity is a major factor towards increased production of wheat in India.

Highlights

- The highest growth in area, production, productivity of wheat was found in Madhya Pradesh.

Keywords: Compound growth rate, decomposition analysis, variability, Krishi Karman Award, production

Wheat is one of the most popular and staple food in India among both vegetarians and non-vegetarians. It compares well with other cereal in nutritive value. It has good nutrition profile with 12.1 per cent protein, 1.8 per cent lipids, 1.8 per cent ash, 2.0 per cent educing sugar, 6.7 per cent pentose, 59.2 per cent starch with good source of mineral of vitamin and nicotinic acid (Agam *et al.* 2017). It processed in different forms like flour, suzi, maida and being eaten by number of consumers in different ways as porridge (*Halwa*), *chapati*, bread and biscuits etc. Besides that, wheat straw and wheat bran are also good source of feed for animals (Yadav *et al.* 2014). India is the second largest producer of wheat in the world, averaging an annual production of 997 lakh tons (FAO Trade Statistics, 2018). India almost exclusively raises winter wheat. Wheat is mainly grown in the Rabi season (October–December to March–May) along with Barley, Lentils, Peas, Mustard and Potatoes. The sowing of winter wheat starts from 1st of October and runs through to the end of December. Wheat is usually begun to head in January, with the harvest following in March, April and May (Tripathi & Mishra, 2017). Farmer faces the problems in wheat cultivation due to poor resource base and non-adoption of recommended techniques (Ahirwar *et al.* 2015).

In the world, India stands at first position in wheat area with share of 12.4 per cent to the total area

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and in production it occupies second position next to China with 11.5 per cent share and this position is continues for more than a decade (FAO Trade Statistics, 2018). In India total wheat area was accounted for 296.51 lakh ha with production of 998.70 lakh tons with average yield of 3368 kg/ha. Highest share in area was contributed by Uttar Pradesh state with 32.89 per cent followed by Madhya Pradesh with 17.92 per cent. In production highest share was contributed by Uttar Pradesh with 31.92 per cent followed by Punjab with 17.85 per cent. Among all the states of the country, Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan and Haryana are the major wheat growing states, which covers around 80% of area and 87% of production of wheat in the country (Directorate of Economics & Statistics, 2017-18).

India is the largest producer and consumer of wheat in the world and therefore there is a need to increase the production of wheat crop so that, it can be exported to other countries and thereby reducing the deficit of balance of payments and also to further boost the economy of a nation. Besides this wheat crop is an important component of buffer stock of the country and livelihood food security mainly depends on this crop. Therefore, keeping in view the importance of wheat crop, the present study was undertaken with following specific objectives:

1. To study the sources and growth pattern of area, production and productivity of wheat in major wheat growing states of India.
2. To study the variation in area, production and productivity of wheat in major wheat growing states of India.

MATERIALS AND METHODS

The present study was undertaken in all the major wheat producing states such as Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan and Haryana. The study was mainly based on time series secondary data on wheat area, production and productivity pertains to last 18 years i.e. 2000-01 to 2017-18 for selected states. The data were collected from the published source of Directorate of Economics & Statistics, Ministry of Agriculture web site. Suitable tools viz; Compound growth rate, decomposition model and coefficient of variation were applied for the study. The details of methods of analysis using following statistical and econometrical models are presented as under.

Relative change

This tool explains comparative change among the components of wheat production while, absolute change does not explain this change. Hence the relative change in the area, production and productivity of wheat of different states were analysed using following formula,

$$\text{Relative change (\%)} = \frac{(C-B)}{(B)} \times 100$$

Where,

C = Triennium average from 2015-16 to 2017-18 (Current year), for the Area, Production and Productivity.

B = Triennium average from 2000-01 to 2002-03 (Base year), for the Area, Production and Productivity.

Trend Analysis & Growth rates

(a) Trend

Linear equation, $Y = a + bx$

$$a = \overline{Y} - b\overline{X}$$

$$b = \frac{\Sigma XY - (\Sigma X)(\Sigma Y)/n}{\Sigma X^2 - (\Sigma X)^2/n}$$

Where,

Y = Dependent variable

a = Constant

b = Regression coefficient

X = Independent variable

$\overline{Y}$ = Mean of Y

$\overline{X}$ = Mean of X

(b) Compound growth rate

CGR = (antilog of b – 1) × 100

(c) $CV = \frac{\sigma}{\overline{Y}} \times 100$

where,

CV = Coefficient of variation

σ = Standard deviation

$\overline{Y}$ = Mean of the Y

Decomposition model

This model was used for estimation of contribution of area, yield and their interaction towards (increase /decrease) change in production of wheat, as model suggested by many researchers.

Area effect: shows percentage share of area in the total production.

$$AE = \frac{\left(A_t - A_0\right)Y_0}{P_t - P_0} \times 100$$

Yield effect: shows percentage share of yield in the total production.

$$YE = \frac{\left(Y_t - Y_0\right)A_0}{P_t - P_0} \times 100$$

Interaction effect: shows percentage share of area and yield in the total production.

$$IE = \frac{\left(Y_t - Y_0\right)\left(A_0 - A_0\right)}{P_t - P_0} \times 100$$

Where,

A_t, P_t and Y_t = Triennium average from 2015-16 to 2017-18 (Current year), for the Area, Production and Productivity

A_0, P_0 and Y_0 = Triennium average from 2000-01 to 2002-03 (Base year), for the Area, Production and Productivity

RESULTS AND DISCUSSION

Wheat Production in India

Wheat production is confined mainly to the northern and central part of India such as Haryana, Punjab, Rajasthan, Madhya Pradesh and Uttar Pradesh which covers around 80 per cent of area and 87 per cent of production of wheat in the country. To a limited extent it is also grown in Bihar, Gujarat and Maharashtra. The data presented in table 1 reveals that the area, production and productivity of wheat crop in India have been increased by 17.58, 39.60 and 18.73 per cent, respectively from its base year (T1) to current year (T2). The maximum relative change in area, production and productivity of wheat was noticed in Madhya Pradesh state with 65.97, 226.32 and 96.62 per cent, respectively. Rajasthan secured second position next to Madhya

Table 1: Relative change in Area, Production and Productivity of Wheat in different States of India

States	Units	T1	T2	Change in contribution (%)	RC
Haryana	A (lakh ha)	23.07 (8.96)	25.24 (8.33)	-0.63	9.42
	P (lakh tons)	94.31 (13.59)	112.21 (11.58)	-2.01	18.98
	Y (tons/ha)	4.09 (152.00)	4.44 (138.75)	-13.25	8.74
Madhya Pradesh	A (lakh ha)	34.65 (13.45)	57.51 (19.00)	5.55	65.97
	P (lakh tons)	52.64 (7.58)	171.79 (17.73)	10.15	226.32
	Y (tons/ha)	1.52 (56.50)	2.99 (93.44)	36.94	96.62
Punjab	A (lakh ha)	34.01 (13.20)	35.05 (11.57)	-1.63	3.06
	P (lakh tons)	150.75 (21.72)	167.82 (17.32)	-4.40	11.33
	Y (tons/ha)	4.43 (164.68)	4.79 (149.68)	-15.00	8.02
Rajasthan	A (lakh ha)	21.32 (8.28)	29.16 (9.63)	1.36	36.75
	P (lakh tons)	56.04 (8.07)	94.08 (9.71)	1.64	67.86
	Y (tons/ha)	2.63 (97.77)	3.23 (100.94)	3.17	22.75
Uttar Pradesh	A (lakh ha)	91.96 (35.70)	96.84 (31.98)	-3.72	5.31
	P (lakh tons)	247.59 (35.67)	291.20 (30.05)	-5.62	17.61
	Y (tons/ha)	2.69 (100.00)	3.01 (94.06)	-5.94	11.69
Other States	A (lakh ha)	52.55 (20.40)	60.04 (17.35)	-3.05	14.25
	P (lakh tons)	92.69 (13.35)	131.79 (13.60)	0.25	42.18
	Y (tons/ha)	1.76 (65.42)	2.19 (68.43)	3.01	24.43
India	A (lakh ha)	257.56 (100.00)	302.84 (100.00)	—	17.58
	P (lakh tons)	694.02 (100.00)	968.89 (100.00)	—	39.60
	Y (tons/ha)	2.69 (100.00)	3.20 (100.00)	—	18.73

***Source:** Directorate of Economics and Statistics.*

T1=Triennium average for 2000-01 to 2002-03; T2=Triennium average for 2015-16 to 2017-18.

***Note:** Figures in parentheses shows percentage to area, production and yield at national level.*

Pradesh with relative change 36.75, 67.86 and 22.75 per cent of area, production and productivity of wheat, respectively. However, Haryana, Punjab and Uttar Pradesh were also showing positive relative change in area, production and productivity of wheat.

It is also noted from the above data that over the period of 18 years' time the contribution of increased area at national level mainly accounted for Madhya Pradesh (5.55%) followed by Rajasthan (1.36%). On the contrary the share of wheat area to national area of wheat in T2 period is declining in major wheat producing states, it is decreasing by 3.72 per cent in Uttar Pradesh and by 1.63 per cent in Punjab. Similarly, the increase in production of wheat in T2 period over T1 period is mainly contributed by Madhya Pradesh (10.15%) on account of increase share of productivity by 36.94 per cent although the average productivity of wheat during T2 period (2.99 tons/ha) is still below the national average of 3.20 tons per ha exhibiting that there is still scope for increasing of wheat production in Madhya Pradesh.

Production Variability and Growth

The data presented in table 2 indicated variability and growth in production components in major wheat producing states of India.

The variability of wheat crop in India for area, production and productivity was 6.81, 13.87 and 8.10 per cent, respectively. The highest variability in area is noted for Madhya Pradesh (20.43%), followed by Rajasthan (16.45%) and other states (7.88%) and lowest variability was noted for Punjab (1.26%), Uttar Pradesh (3.12%) and Haryana (4.33%). The highest variability in production is noted for Madhya Pradesh (47.1%), followed by Rajasthan (21.67%) and others (16.45%) and lowest variability was noted for Punjab (7.05%), followed by Haryana (10.53%) and Uttar Pradesh (11.11%). Whereas the highest variability in productivity is noted for Madhya Pradesh (26.73%) and it is lowest for Punjab (6.37%) states. This revealed that this crop is well established in the cropping pattern of Punjab, Uttar Pradesh and Haryana due to assured irrigation supply during Rabi season through canals and tube wells. On the other hand, in Madhya Pradesh and Rajasthan the area allocation to this crop mainly depends on monsoon rains.

It is also indicated that over the year area, production and productivity for wheat in India has been increased with positive and highly significant compound growth rate of 1.21, 2.46 and 1.23 per cent, respectively. Madhya Pradesh is showing maximum positive and highly significant compound growth rate of area, production and productivity by3.49, 8.21 and 4.56 per cent, respectively. The compound growth rate of area was positive and highly significant for Haryana (0.69%), Punjab (0.18%), Rajasthan (2.59%), Uttar Pradesh (0.49%) and other states were also showing positive and significant CGR (0.85%). The positive and highly significant compound growth rate of production was observed in Haryana (1.5%), Madhya Pradesh (8.21%), Punjab (0.91%), Rajasthan (3.92%), Uttar Pradesh (1.19%) and others (2.6%). Haryana showed positive and significant compound growth rate of productivity with 0.8 per cent whereas Madhya Pradesh, Punjab, Rajasthan and others indicated positive and highly significant compound growth rate with 4.56, 0.72, 1.29 and 1.74 per cent. Uttar Pradesh depicted positive but non-significant

Table 2: Variability and Compound Growth Rates of wheat in major wheat growing states of India (2000-01 to 2017-18)

States	**CV (%)**			**CGR (%)**		
	Area	**Production**	**Yield**	**Area**	**Production**	**Yield**
Haryana	4.33	10.53	7.34	0.69**	1.50**	0.80*
Madhya Pradesh	20.43	47.10	26.73	3.49**	8.21**	4.56**
Punjab	1.26	7.05	6.37	0.18**	0.91**	0.72**
Rajasthan	16.45	21.67	8.00	2.59**	3.92**	1.29**
Uttar Pradesh	3.12	11.11	9.21	0.49**	1.19**	0.69
Other States	7.88	16.45	11.13	0.85*	2.60**	1.74**
India	6.81	13.87	8.10	1.21**	2.46**	1.23**

Source: *Directorate of Economics and Statistics.*

*** Significant at 1% level of probability, * Significant at 5% level of probability.*

Table 4: Decomposition of output growth of wheat in major wheat growing States of India (2000-01 to 2017-18)

States	AC in Production (000′ Tons)	Area effect (000′ Tons)	Yield effect (000′ Tons)	Interaction effect (000′ Tons)
Haryana	1790.03	888.36 (49.63)	824.05 (46.04)	77.62 (4.34)
Madhya Pradesh	11915.00	3472.94 (29.15)	5086.57 (42.69)	3355.49 (28.16)
Punjab	1707.72	461.06 (27.00)	1209.67 (70.84)	37.00 (2.17)
Rajasthan	3803.56	2059.71 (54.15)	1275.21 (33.53)	468.64 (12.32)
Uttar Pradesh	4360.55	1313.57 (30.12)	2893.47 (66.36)	153.51 (3.52)
Other	3909.60	4003.98 (102.41)	1712.47 (43.80)	-1806.85 (-46.22)
India	27486.46	12199.62 (44.38)	13001.44 (47.30)	2285.40 (8.31)

Note: *Figures in parentheses indicate percentages to the total production in each state.*

growth rate of productivity (0.69%). The highest growth in area, production and productivity of wheat in Madhya Pradesh helps in confirming Krishi Karman Award for last five consecutive years. The similar results were reported by Mishra *et al.* (2014) and Nahatkar & Rajan, (2015).

Decomposition analysis

For estimating the contribution of area and yield towards increase/decrease in production of wheat the simple decomposition model was used in which contribution of productivity is the part of production due to increased wheat acreage over the base year productivity. The contribution of interaction is the part of production due to increased yield in the increased wheat acreage. The analysed data for different states are presented in table 3. It is observed from the data that yield contributed positively in increasing the production of wheat and its effect on total wheat production in the India was 47.3 per cent followed by area effect (44.38%). The contribution of interaction effect towards increased wheat production was only 8.31 per cent showing that over the period the increased productivity of wheat contributed more as compared to increase in area and their interactions.

The contribution of area was highest in other states (102.41%), Rajasthan (54.15%) and Haryana states (49.63%). On the contrary the yield effect was highest in Punjab (70.84%), Uttar Pradesh (66.36%), Madhya Pradesh (42.69%) and for country as a whole (47.30%). The interaction effect was highest in Madhya Pradesh (28.16%) as compared to other major wheat producing states. The highest relative change in production was also noted for Madhya Pradesh (11915.00 th tons) and only enhance yield over the years increased production by 5086.57 th tons.

CONCLUSION

The analysis of variability and growth in production components of wheat in India and major wheat producing states leads to conclude that the variability in area, production and yield was lower in states where this crop is well established in the cropping pattern on account of development of assured irrigation infrastructure facilities of canals and tube wells. The highest growth rates in area, production and productivity of wheat for Madhya Pradesh shows that this state is emerging as food bowl of India on account of increased productivity and area due to assured electricity supply for using available irrigation potentials. Therefore, it is recommended that the varieties suited to irrigated ecosystem of wheat production along with matching production technologies should be promoted to tap the available potential for quality wheat production in central part of India.

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Trends in Area, Production, Productivity and Trade of *Chick Pea* in India

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ABSTRACT

Chick pea is an important pulse crop and steady source of human nutrition, as it is an important component of production systems that are resilient to climate change. Asia and Africa contribute around 80 per cent of world production. India is a leader of production and consumption of *chick pea* as growing it is cost effective option for developing countries but yield of *chick pea* is comparatively low due to poor spread of improved varieties and technologies. In this study, growth trend of area, production and productivity of *chick pea* was estimated. The contribution of area and productivity in the production growth were also estimated and it was found that the contribution of area in production was high. Demand and supply gap of *chick pea* has been increased, so India has become the major importer of *chick pea*. Thus, to enhance domestic *chick pea* production and productivity generation and dissemination of technologies is a matter of great challenge and favorable policy measures are to requisite.

Highlights

- India is leading in production and consumption of *chick pea* but productivity is comparatively low due to poor spread of improved varieties and technologies.

Keywords: Chick pea, production, trend, import, export

Pulses historically have been one of the most important constituent of the Indian cropping and consumption patterns and long considered “the poor man’s meat” as it is one of the less expensive sources of protein (Mohanty and Satyasai 2015). Among pulses, *chick pea* (*Cicer arietinum*) is preferred to food legumes because of its multiple uses for growing population across the world. During 2017-18, globally it was grown on 149.66 lakh ha area, with the total production of 162.25 lakh tonnes (FAOSTAT, 2019) and average productivity of 1252 kg/ha. Out of which, 71 per cent of global area with 70 per cent of global production of *chick pea* is contributed by India as it ranks 1st in area and production but lags behind several countries in terms of productivity because of poor adoption of improved varieties and production technologies by farmers’. Apart from India, Australia (12.35%), Myanmar (3.25%) and Ethiopia (2.92%) are the major *chick pea* producing countries of the world. The *chick pea* production in India has gone up from 38.55 to 112.29 lakh tonnes during 2000-01 to 2017-18, while the area has also gone up from 51.85 to 105.61 lakh ha, whereas, the yield has steadily increased from 744 kg/ha to 1063kg/ha during the same period (Table 2). Madhya Pradesh is leading state in terms of area and production as it contributes around 34 and 40 per cent share to the total area and production of gram in the country (Annual Report 2017-18, Directorate of Pulses Development). Due to stagnant productivity over the years, *chick pea* import to India has been bagged in largely to

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counterbalance domestic short supply and hence it became the major importer of *chick pea* (5.90 lakh tonnes) during 2017-18. The countries which exports *chick pea* to India are Canada, Australia, Iran, Myanmar, Tanzania, Pakistan, Turkey and France. In spite of this, India is also a major exporter ranking third i.e. 2.12 lakh tonnes (FAO2019) and its export destinations are USA, UK, Saudi Arabia, UAE, Sri Lanka, and Malaysia. Therefore, this study examines the *chick pea* production, value and trade on a global and country basis to determine trends in area, production and yield.

METHODOLOGY

Theoretical foundation of the study about global scenario of *chick pea* is based on the secondary data available at the Food and Agriculture Organization (FAO) Corporate Statistical Database (FAOSTAT) for the period of 2017-18. Detailed area, production and yield data of *chick pea* were available in "Agriculture statistics at a glance" for India. When the analysis was carried out for this study, the time series data on area, production and yield of *chick pea* were taken from 2000-01 to 2017-18. Statistical measures such as the average, percentage and the compound growth rates have been computed to analyze the trends. Compound growth rates of area, production and yield of *chick pea* for India as a whole were estimated for the period (2000-01 to 2017-18) by fitting an exponential function of the following form $Y = Ab^t$. It was converted into log linear function with the help of logarithmic transformation as under:

$$Log\ Y = Log\ A + bt$$

Where, Y = Dependent variable Area/Production/ Yield

A = Constant

t = Independent variable (time in a year)

Compound growth rate was calculated by using the formula:

$$CGR = b * 100$$

For significant testing t value was calculated using formula:

$$t = \frac{CGR}{SE(CGR)}$$

Decomposition of Analysis

To estimate the contribution of area, productivity and interaction of the two in total production of *chick pea*, the following additive scheme of decomposition can be used:

$$1 - \left[\frac{Y_o \Delta A}{P}\right] + \left[\frac{A_o \Delta Y}{P}\right] + \left[\frac{\Delta A \Delta Y}{P}\right]$$

Where,

P = Change in production

A_O = Area in base year

An = Area in current year

Y_O = Yield in base year

Yn = Yield in current year

ΔA= Change in area ($An - A_O$)

ΔY = Change in yield ($Yn - Y_O$).

RESULTS AND DISCUSSION

Global Scenario of *Chick Pea*

Chick pea is an important pulses crop and grown all over the world. About 71 per cent of global area with 70 per cent of global production of *chick pea* is contributed by India. There are mainly two types *chick pea* produced i.e. Desi and Kabuli. The Desi type *chick peas* contribute to around 80 per cent and the Kabuli type around 20 per cent of the total *chick pea* production. The major producing countries of Desi *chick pea* are India, Pakistan, Myanmar, Australia and Bangladesh. Countries like Turkey, Iran, Ethiopia, Mexico, Syria, Spain, Canada, United States, Algeria, Ethiopia, Malawi, Sudan, Tanzania, Tunisia, Spain and Portugal are the major producers of Kabuli *chick pea*. In case of productivity Ethiopia is leading country (2038 kg/ha) followed by Mexico (1918 kg/ha) and Australia (1875 kg/ha).

It just contributes 2.92 per cent and 1.55 per cent in production and area of the world but productivity is very high as compared to India. Productivity of India was found to be 1063 kg/ ha. So, in productivity India ranks 6th in the world this is a point of concern (Table 1). It can be suggested from the data that more focus should be given on the improvement of the *chick pea* varieties.

Table 1: World area, production and productivity of chick pea in 2017-18

Country	Area (Lakh ha)	% Contribution	Production (Lakh tonnes)	% Contribution	Yield (kg/ha)
India	105.61	70.57	112.29	69.21	1063
Australia	10.69	7.14	20.04	12.35	1875
Pakistan	9.71	6.49	3.3	2.03	340
Iran	5.66	3.78	2.71	1.67	480
Russian Federation	4.57	3.05	4.18	2.58	916
Turkey	3.92	2.62	4.7	2.90	1197
Myanmar	3.76	2.51	5.27	3.25	1402
USA	2.43	1.62	3.13	1.93	1291
Ethiopia	2.32	1.55	4.74	2.92	2038
Mexico	0.99	0.66	1.89	1.16	1918
World	**149.66**		**162.25**		**1252**

Source: *Food and Agriculture Organization (2019).*

Indian Scenario of *Chick Pea*

Growth trends of *chick pea*

In India, *chick pea* producing states are Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra and Andhra Pradesh. Madhya Pradesh has major share *i.e.* around 40 per cent in the India's *chick pea* production. The level of growth in output is jointly determined by the growth rate in area and that in yield. The purpose is to examine the performance of *chick pea* in the country and see if there have been noticeable changes during the years 2000-01 to 2017-18. Compound growth rates of area, production and productivity of *chick pea* were worked out to 3.1, 4.7 and 1.5 per cent respectively during 2000-01 to 2017-18 and it is found that there is significant increase in area, production and productivity of *chick pea* in India (Table 2). Keeping in view, the per capita availability of *chick pea*, there is an urgent need to increase the production through crop specific and region specific strategies. This bleak performance of expansion of area under *chick pea* and consequent slow growth of production is cause of concern, as India is the largest producing, consuming and importing country.

Table 2: Compound growth rate in area, production and productivity of *chick pea* in India

Years	Area (Lakh ha)	Production (Lakh tonnes)	Yield (kg/ha)
2000-01	51.85	38.55	744.00
2001-02	64.16	54.73	853.00
2002-03	59.06	42.37	717.00
2003-04	70.48	57.18	811.00
2004-05	67.15	54.69	815.00
2005-06	69.26	56.00	808.00
2006-07	74.94	63.34	845.00
2007-08	75.44	57.49	762.00
2008-09	78.93	70.60	895.00
2009-10	81.69	74.76	915.00
2010-11	91.86	82.21	895.00
2011-12	82.99	77.02	928.00
2012-13	85.22	88.32	1036.00
2013-14	99.27	95.26	960.00
2014-15	82.51	73.32	889.00
2015-16	83.99	70.58	840.00
2016-17	95.39	90.75	951.00
2017-18	105.61	112.29	1063.00
Coefficient (b)	0.031 (0.003)	0.047 (0.006)	0.015 (0.003)
CGR (%)	3.1**	4.7**	1.5**

*** Significant at 5 per cent level of significance.*
Figures in parentheses are standard error.

Decomposition analysis

The analysis of the factors affecting the total production of the *chick pea* (Table 3) indicates that the effect of area is maximum in *chick pea* (54.24 per cent). The contribution of Productivity is 22.43 per cent. Chick pea shows positive interaction effect (23.26 per cent).

Table 3: Area effect, yield effect and interaction effect on production growth of *chick pea*

Sr. No.	Description (%)	Chick pea
1	Change in area variance	54.24
2	Change in yield variance	22.43
3	Interaction between changes in mean area and mean yield	23.26

Export Import Intelligence of *Chick Pea*

Australia is the major exporter of *chick pea* in the world. It nearly meets half of the world export demand. The *chick pea* export of the country was 9.26 lakh tonnes to the market followed by Russia (2.43 lakh tonnes) as shown in table 4. India while being the major producer and importer of *chick pea* is also a major exporter ranking third (2.12 lakh tonnes), after Russian federation (FAO2019). Mexico rank fourth with the commodity being exported to over 50 countries worldwide.

Table 4: Major *chick pea* exporting countries from 2010 to 2018

Sl. No.	Country	Export (lakh tonnes)
1	Australia	9.26
2	Russian Federation	2.43
3	India	2.12
4	Mexico	1.49
5	Canada	0.81
6	Argentina	0.77
7	USA	0.70
8	Ethiopia	0.59
9	Turkey	0.21

Source: *FAO, 2019.*

The table 5 revealed that India is the major importer of *chick pea* due to its large population size. India imports 5.90 lakh tonnes *chick pea* followed by Bangladesh (2.08 lakh tonnes) and Algeria (0.72 lakh tonnes). It is found that India's quantity of import exceeds the quantity of export and it reflects the negative balance of trade in case of *chick pea*.

Table 5: Major *chick pea* importing countries from 2010 to 2018

Sl. No.	Country	Import (lakh tonnes)
1	India	5.90
2	Bangladesh	2.08
3	Algeria	0.72
4	Sri Lanka	0.27
5	Egypt	0.25
6	Iran	0.18
7	Iraq	0.08
8	France	0.05
9	Greece	0.04

Source: *FAO, 2019.*

Trade Destination of *Chick Pea*

Chick pea have entered world trade as consuming countries have been unable to meet demand through their domestic production. India, while being the largest producer and importer of *chick pea* is also a major exporter. Major export destinations of India for Chick pea were Pakistan (21.60%) followed by Algeria (11.6%) and U Arab EMTS (10.60%). India imports maximum share of *chick pea* from Australia (85.10%) followed by Russia (4.7%) and Tanzania (3.8%) as shown in table 6. India also exports *chick pea* to different countries namely USA, UK, Saudi Arabia, UAE and Sri Lanka. The major trading centers of Chick pea in India are Indore (Madhya Pradesh), Bhopal (Madhya Pradesh), Vidisha (Madhya Pradesh), Jalgaon (Maharashtra), Latur (Maharashtra), Mumbai (Maharashtra), Akola (Maharashtra), Jaipur (Rajasthan), Bikaner (Rajasthan), Kota (Rajasthan), Jodhpur (Rajasthan), Sriganaganagar (Rajasthan), Hanumangarh (Rajasthan), Delhi, Chennai, Kanpur, Hapur, Hyderabad, Vijayawada, Gulbarga, Sirsa, Jalandhar, Ludhiana and Sangrur.

Table 6: India's trade destinations of *chick pea* in 2017-18

Sl. No.	Export Destinations	Import Sources
1	Pakistan (21.60%),	Australia (85.1%),
2	Algeria (11.60%)	Russia (4.7%)
3	U Arab EMTS (10.60%)	Tanzania (3.8%)
4	Saudi Arab (9.50%)	USA (1.4%)
5	Sri Lanka (7.30%)	Canada (0.91%)

Figures in parenthesis indicates percentage share of global import/ export
Sources: *Ministry of Commerce and Industry. GOI.*

CONCLUSIONS

Chick pea is an important source of income and nutrition to number of smallholder farmers and consumers around the world. The main objective of this study was to examine the global and regional trends in area, production, yield and trade of *chick pea*. Present study revealed that, India ranks first in terms of area and production but lags behind several countries in terms of productivity of *chick pea*. Low yield in India compared to other *chick pea* growing countries is attributed to poor spread of improved varieties and technologies, abrupt climatic changes, vulnerability to pests and diseases, and generally declining growth rate of total factor productivity. Production is the combined effect of area and productivity, growth of production is majorly contributed by areas. Due to stagnant production and productivity over the years, *chick pea* import to India have been brought in largely to counterbalance domestic short supply of pulse as compared to emerging demand.

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Impact of Agricultural Price Policy on Major Food Crops in Haryana

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ABSTRACT

The present study aimed to analyze the impact of Agricultural Price Policy on major food crops in Haryana. The Secondary data on Farm Harvest Prices (FHP) and Minimum Support Prices (MSP) of major food crops were collected from Statistical Abstract of Haryana, Directorate of Marketing and Inspection and Commission for Agricultural Cost and Prices for the period 2007-08 to 2017-18. The effectiveness of the price policy during the harvest periods was examined by the deviations of FHP from MSP and classified into positive and negative deviations (to examine whether market prices ruled higher or lower than the minimum support prices). Gap between FHP and MSP resulted that in mostly cases FHP is higher than MSP because higher demand due to more procurement for central part than supplies does not allow the market prices to fall below MSP. In recent years, market prices ruled higher than MSP. The impact of MSP on area is higher but there is non-significant impact of MSP on productivity of food crops. The study revealed that there is significant variation in areas of food crops due to previous year's minimum support prices of the food crops but there is non-significant variation in productivity of food crops.

Highlights

- FHP is higher than MSP of food crops. Impact of MSP is significant on area due to previous year's MSP and non significant on Productivity.

Keywords: Farm Harvest Price, Minimum Support Price, Agricultural Price Policy

INTRODUCTION: In developing countries, where agriculture is very important, the Agricultural prices occupy a lead position in the price structure. The study of price behaviour is a crucial requisite of any sound price policy. Agricultural Price Policy and price support system have come under academic scrutiny due to the recent changes towards liberalization of the Indian economy (Sudhakar & Wale, 2017). As agriculture becomes more market oriented and marketable surplus increases, changes in relative prices of different farm products affect the acreage that a farmer would like to put under each crop which in turn would also affect the level of production of different enterprises. Any agricultural policy analysis needs to deal with the problems or factors influencing demand of the agricultural output. The very important decisions in agricultural production such as how do farmers decide what to produce and how much to produce? What policy instruments and other factors influence their decisions regarding acreage allocation under different crops must be understood so as to construct a sound and successful agricultural policy. The conclusion of supply in agriculture are likely to be made on the knowledge relating to technical co-efficient, prices of inputs and output. The MSP is fixed by government before sowing season, but awareness level among farmer is very

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low. Hence this study focuses on the method of estimating MSP based on 2018 Budget proposed by the government whiz "at least 50 per cent more than the weighted average cost of the production. A portal would be developed to create awareness among the farmers. (Jain *et al.* 2018).

Minimum Support Price (MSP) is a fundamental component of Agricultural Price Policy of India. It targets to corroborate support price to farmers and reasonable prices to consumers through Public Distribution System (PDS) (Parikh & Singh 2007). The price support system was conceptualized during pre-green revolution period as an governmental mechanism for incentivizing farmers to acclimatize new technologies (Planning Commission 2005; Deshpande 2008). Later, Agriculture Price Commission (APC) was established in the year 1965, based on Jha committee recommendations to recommend support prices for crops after considering the cost of cultivation (Kadasiddappa *et al*. 2013). It was reflected in the revised terms of reference of Agricultural Prices Commission (which was later renamed as Commission for Agricultural Costs and Prices) with a shift from maximizing the production to developing a production pattern regular with the overall needs of the economy (**A**charya, 1997). The Commission for Agricultural Costs and Prices (CACP) recommends Minimum Support Price (MSP) for 26 agriculture crops *i.e*. cereals (paddy, wheat and *ragi*), coarse cereals (barley, jowar, bajra and maize), pulses (*gram*, *arhar*/ *tur*, *moong*, *urad* and lentil), oilseeds (groundnut, rapeseed/mustard, toria, soyabean, sunflower seed, sesame, safflower seed and *niger* seed), raw cotton, raw jute, copra, de-husked coconut, sugarcane, VFC tobacco. Broad objectives of the Agriculture Price Commission (APC) are to ensure remunerative prices to farmers and affordable prices to consumers and promote sustainable use of all resources towards socially desirable crop mix (Parikh & Singh 2007). The worse situation of the price policy as far as concerned with the area allocation under gram crop because the area has been decreasing in spite of providing more prices for the crop (Godara & Poonia, 2013).

Price incentives in the form of minimum support prices helped India to increase food production during green revolution period. Minimum Support Prices (MSP) also aims at procuring food grains from food surplus states for distribution through Public Distribution System and maintaining buffer stock and thus fulfil the demand supply gap (Jha & Srinivasan 2006; Chand 2008). Price incentives in the form of MSP are credited for the increase in area under wheat and rice in the green revolution states like Haryana and Punjab. Also, the Agricultural price policy is considered to have favoured food crops more than the other crops. As a result, a large mass of good quality and was shifted from oilseeds, pulses and other important crops to paddy and wheat crops, creating a serious imbalance in the demand and supply of many other agricultural commodities (Chand, 2008). In other regions of the country due to small marketable surpluses, the Agricultural price policy is considered to be ineffective as the government has less interest in procurement operations. So, it is argued that the market prices for wheat and paddy crop rule lower than the Minimum Support Price (MSP) in these are as during post-harvest period and shoot up during the lean periods, which is usually not the case in the surplus producing regions (ADRT, 2003). In recent years, the Minimum Support Price (MSP) policy has been criticized by both farmers and proponents of free trade. The heavy subsidisation of agricultural exports by developed countries due to WTO obligations, the situation is fast changing. Since international agricultural prices have become lower than the Indian agricultural prices, farmers in the state have been put to a serious disadvantage (Debashis Sarkar, 2011).

MATERIALS AND METHODS

Selection of crops

The major food crops i.e. wheat, rice, bajra, barley, gram, maize, rapeseed/ mustard were selected purposively for the study. The present study was primarily based on secondary data collected from Statistical Abstract of Haryana, Directorate of Marketing and Inspection (DMI), Ministry of Agriculture and Farmers Welfare Government of India (Faridabad), CACP, other published and unpublished sources. The yearly time series data on prices of major food crops were collected for Haryana state covering period from 2007-08 to 2017-2018.

Analytical Tools and Techniques

Gap between FHP and MSP of major food crops in Haryana:

The study is based on the secondary data on farm harvest prices and minimum support prices of major food crops in Haryana state. Based on the data availability, the time period chosen was 2007-08 to 2017-18. To study the effectiveness of the price policy during the harvest periods, the deviations of Farm Harvest Prices (FHP) from the Minimum Support Prices (MSP) were worked out and divided into positive and negative deviations to examine whether market prices ruled higher or lower over the minimum support prices. The negative deviations reflected ineffectiveness of MSP policy for producers. The formulae used for the mean absolute negative / positive deviation was as follows:

$MAPD$ or $MAND = 1/n \sum |FHP_i - MSP_i|$

If, $FHP > MSP$ = Positive deviation (PD)

$FHP < MSP$ = Negative deviation (ND)

Where, $MAPD$ = Mean absolute positive deviation,

$MAND$ = Mean absolute negative deviation,

FHP = Farm harvest price,

MSP = Minimum support price, and

n = Frequency of positive or negative deviations.

These deviations were adjusted with MSP in order to examine the degree of their deviation from the MSP. The formulae used for the adjusted mean negative /positive deviation was as follows:

$AMPD$ or $AMND = 1/n \sum(|FHP_i - MSP_i| / MSP_i)*100$

Where,

$AMPD$ = Adjusted mean positive deviation, and

$AMND$ = Adjusted mean negative deviation

The significance of gap between FHP and MSP of food crops was tested by two sample t test.

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{s\sqrt{\frac{1}{n_x} + \frac{1}{n_y}}}$$

Where,

$\bar{x}$ = mean of FHP of size n_x

$\bar{y}$ = mean of MSP of size n_y

s_p^2 = pooled variance

$$s^2 = \frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{(n_x - 1) + (n_y - 1)}$$

Impact of Minimum Support Prices (MSPs) on major food crops in Haryana To study the impact of lagged Minimum Support Prices (MSPs) on the acreage allocation, production and productivity of food crops in Haryana, linear and logarithmic forms of equations have been fitted. The food crops included wheat, rice, bajra, barley, gram, maize and rapeseed/ mustard for study purpose. The previous year's MSPs generally influence the Producer farmers' decision on acreage allocation for the current year. The linear type of equation has been used as:

1. Linear regression equation:

$A_t = a + b\ P_{t-1}$

$P_t = a + b\ P_{t-1}$

$Y_t = a + b\ P_{t-1}$

The logarithmic type of equation has been used as:

2. Logarithmic regression equation:

$Log\ At = log\ a + b\ P_{t-1}$

$Log\ P_t = log\ a + b\ P_{t-1}$

$Log\ Y_t = log\ a + b\ P_{t-1}$

Where, A_t = Area of food crops at (t)th period,

P_t = Production of food crops at (t)th period,

Y_t = Productivity of food crops at (t)th period,

P_{t-1} = Minimum Support Prices of food crops taken in per quintal at (t-1) th period.

Linear type of function found a better fit than logarithmic function.

RESULTS AND DISCUSSION

Deviations of FHPs from MSPs of major food crops in Haryana from 2007-18

To examine the effectiveness of MSP policy for food crops in Haryana, difference between its FHP and MSP was calculated in different years. Wheat, barley, maize experienced positive deviations 11 times in 11 years during 2007-18. This means that the average FHP was equal to or ruled higher than MSP in 11 times out of 11 years. The adjusted difference (positive) between MSP and FHP was as low as 100 per cent of MSP and the negative

Table 1: Gap between Farm Harvest Price and Minimum Support Price of wheat, rice and bajra crop during 2007-08 to 2017-18

	Wheat			Rice			Bajra		
Year	**FHP (₹/qtl)**	**MSP (₹/qtl)**	**Gap between FHP and MSP (₹/qtl)**	**FHP (₹/qtl)**	**MSP (₹/qtl)**	**Gap between FHP and MSP (₹/qtl)**	**FHP (₹/qtl)**	**MSP (₹/qtl)**	**Gap between FHP and MSP (₹/qtl)**
2007-08	1000.00	1000.00	—	716.14	710.00	6.14	689.62	600.00	89.62
2008-09	1081.89	1080.00	1.89	907.56	850.00	57.56	802.92	840.00	-37.08
2009-10	1100.00	1100.00	—	963.57	1000.00	-36.43	860.80	840.00	20.80
2010-11	1173.76	1120.00	53.76	1056.57	1000.00	56.57	891.79	880.00	11.79
2011-12	1289.50	1285.00	4.50	1280.00	1080.00	200.00	986.88	980.00	6.88
2012-13	1350.00	1350.00	—	1436.00	1250.00	186.00	1220.15	1175.00	45.15
2013-14	1430.00	1400.00	30.00	1533.06	1310.00	223.06	1305.00	1250.00	55.00
2014-15	1486.49	1450.00	36.49	1565.00	1360.00	205.00	1352.78	1250.00	102.78
2015-16	1533.94	1525.00	8.94	1570.00	1410.00	160.00	1354.09	1275.00	79.09
2016-17	1626.39	1625.00	1.39	1620.13	1470.00	150.13	1365.56	1330.00	35.56
2017-18	1744.42	1735.00	9.42	1650.42	1550.00	100.42	1444.49	1425.00	19.49

Note*: The gap between FHP and MSP do not differ significantly at (5 %) level of significance. FHP- Farm Harvest Price; MSP- Minimum Support Price.*

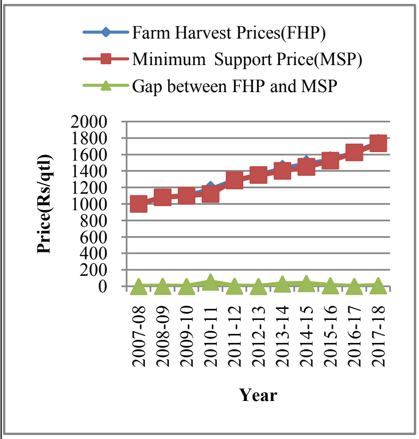

Fig. 1: FHP and MSP of wheat crop

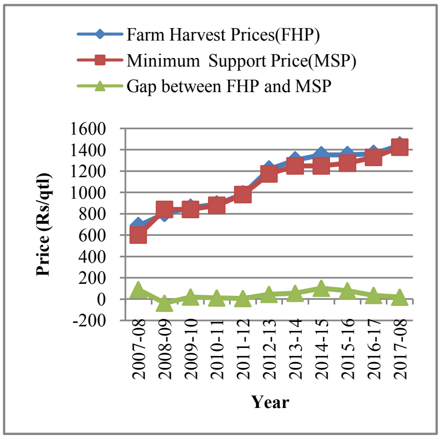

Fig. 2: FHP and MSP of rice crop

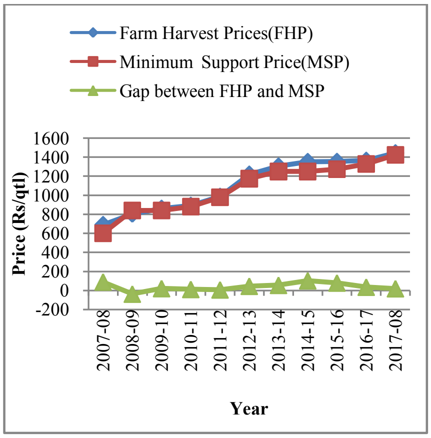

Fig. 3: FHP and MSP of bajra crop

difference was nil. Rice, bajra, gram and rapeseed/mustard experienced positive deviations 10 times and negative deviation 1 time in 11 years during 2007-18. This means that the average FHP was equal to or ruled higher than MSP in 10 times and lower than MSP in one time out of 11 years. The adjusted difference (positive) between MSP and FHP was as low as 90 per cent of MSP and the negative difference was 10 per cent of MSP

Impact of Minimum Support Prices (MSPs) on major food crops in Haryana during 2007-18

To study the impact of lagged Minimum Support Prices (MSPs) on the acreage allocation, production and productivity, linear and logarithmic form of equations have been fitted. As linear type of function had found a better fit than logarithmic function, the former had been presented here. The previous year MSPs had been used here since these prices generally influence the farmers' decision on acreage allocation for the current year.

Impact of MSP on area of major food crops in Haryana during 2007-18

Impact of MSP on area of major food crops in Haryana are presented in table 5. The numerical values of the linear function for food crops indicates that R^2 is significant at 1 per cent level and supports the results that variation in areas of food crops is explained by the explanatory variable, *i.e.* previous

Table 2: Gap between Farm Harvest Price and Minimum Support Price of Barley, Gram, Maize, Rapeseed/ Mustard crop during 2007-08 to 2017-18

	Barley			Gram			Maize			Rapeseed/ Mustard		
Year	**FHP (₹/qtl)**	**MSP (₹/qtl)**	**Gap between FHP and MSP (₹/qtl)**	**FHP (₹/qtl)**	**MSP (₹/qtl)**	**Gap between FHP and MSP (₹/qtl)**	**FHP (₹/qtl)**	**MSP (₹/qtl)**	**Gap between FHP and MSP (₹/qtl)**	**FHP (₹/qtl)**	**MSP (₹/qtl)**	**Gap between FHP and MSP (₹/qtl)**
2007-08	1091.58	650.00	441.58	2645.65	1600.00	1045.65	865.59	600.00	265.59	2380.58	1800.00	580.58
2008-09	881.65	680.00	201.65	2310.83	1730.00	580.83	901.39	840.00	61.39	2365.80	1830.00	535.80
2009-10	896.00	750.00	146.00	2321.63	1760.00	561.63	934.00	840.00	94.00	2341.00	1830.00	511.00
2010-11	1019.59	780.00	239.59	2940.00	2100.00	840.00	986.67	880.00	106.67	2463.71	1850.00	613.71
2011-12	1202.35	980.00	222.35	3915.50	2800.00	1115.50	1116.85	980.00	136.85	3489.43	2500.00	989.43
2012-13	1287.43	980.00	307.43	3739.02	3000.00	739.02	1315.00	1175.00	140.00	3416.19	3000.00	416.19
2013-14	1457.50	1100.0	357.50	3506.15	3100.00	406.15	1475.00	1310.00	165.00	3437.50	3050.00	387.50
2014-15	1281.19	1150.0	131.19	4069.44	3175.00	894.44	1491.00	1310.00	181.00	3511.21	3100.00	411.21
2015-16	1283.78	1225.0	58.78	4072.83	3425.00	647.83	1496.25	1325.00	171.25	3523.72	3350.00	173.72
2016-17	1360.87	1325.0	35.87	4807.87	4000.00	807.87	1498.42	1365.00	133.42	3501.25	3700.00	-198.75
2017-18	1427.59	1410.0	17.59	4307.00	4400.00	-93.00	1528.33	1425.00	103.33	4041.67	4000.00	41.67

Table 3: Significance of gap between FHP and MSP of food crops during 2007-2018

Crops	**Mean FHP**	**MSP**	**T value $t_{cal\ (5\%)}$**	**$t_{tab(5\%)}$**	**D.f**
Wheat	1346.94	1333.63	0.89	2.09	20
Rice	1299.86	1180.91	0.37	2.09	20
Bajra	1115.83	1076.82	0.74	2.09	20
Barley	1199.05	1002.72	0.063	2.09	20
Gram	3512.36	2826.36	0.086	2.09	20
Maize	1237.14	1095.45	0.24	2.09	20
Rapeseed/ Mustard	3133.81	2728.18	1.72	2.09	20

Note: *$t_{cal} < t_{tab}$ that means H_0 is accepted at (5 %) level of significance and conclude that the gap between FHP and MSP do not differ significantly.*

Table 4: Deviations of FHPs vis-à-vis MSPs of major food crops in Haryana: 2007-2018

	Negative deviations					Positive deviations				
Crops	**Frequency**	**MAND (₹/q)**	**Range (₹/q)**	**AMND (₹/q)**	**%**	**Frequency**	**MAPD (₹/q)**	**Range (₹/q)**	**AMPD (₹/q)**	**%**
Wheat	0	00.00	—	—	—	11	12.45	0-53.76	1.02	100
Rice	1	-36.43	-36.43	-3.64	10	10	134.49	6.14-223.06	10.68	90
Bajra	1	-37.08	-37.08	-4.41	10	10	46.62	6.88-102.78	04.62	90
Barley	0	00.00	—	—	—	11	196.32	35.87-441.58	23.14	100
Gram	1	-93.00	-93.00	-2.11	10	10	793.89	561.63-1115.5	29.58	90
Maize	0	00.00	—	—	—	11	141.68	61.39-265.59	14.28	100
Rapeseed/mustard	1	-198.75	-198.75	-5.37	10	10	466.08	41.67-989.43	20.83	90

Note: **Zero deviations (FHP=MSP) were considered positive deviations indicating success of the MSP policy Average= Average of the difference of FHP from MSP (+ve or –ve) and %= Percentage of average positive or negative deviations over MSP.*

year's Minimum Support Prices (MSPs) of the food crops. The result revealed that 68 per cent variation in area of wheat, 72 per cent variation in area of rice, 72 per cent variation in area of bajra, 48 per cent variation in area of barley, 71 per cent variation in area of gram, 87 per cent variation in area of maize and 20 per cent variation in area of rapeseed/ mustard is explained by independent variable *i.e.* lagged MSP. The elasticity for these variables is significant at 1 per cent level in case of area of food crops. The value of elasticity has found as 0.159, 0.25, -0.361, -0.027, -0.031, -0.008, 0.135 per cent indicating thereby that previous year price influences current year's area of major food crops

Table 5: Impact of MSP on area of major food crops in Haryana during 2007-18

Crops	R^2	S.E of R	Linear regression equation
Wheat	0.68	27.71	$y = 2323 + 0.159x$
Rice	0.72	47.89	$y = 972.0 + 0.25x$
Bajra	0.72	64.00	$y = 858.0 + (-0.361)x$
Barley	0.48	7.04	$y = 62.82 + (-0.027)x$
Gram	0.71	16.03	$y = 152.5 + (-0.031)x$
Maize	0.87	0.958	$y = 17.75 + (-0.008)x$
Rapeseed/mustard	0.20	188.44	$y = 97.49 + 0.135x$

y = *Area* $x = MSP_{t-1}$.

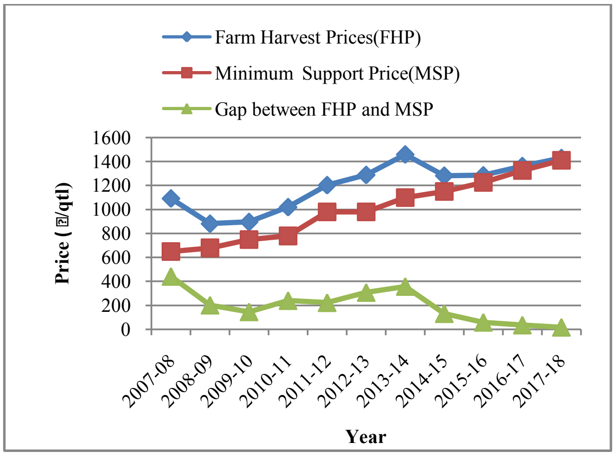

Fig. 4: FHP and MSP of barley crop

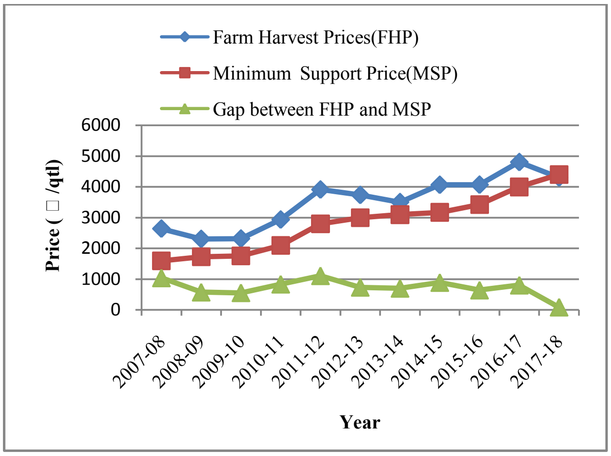

Fig. 5: FHP and MSP of gram crop

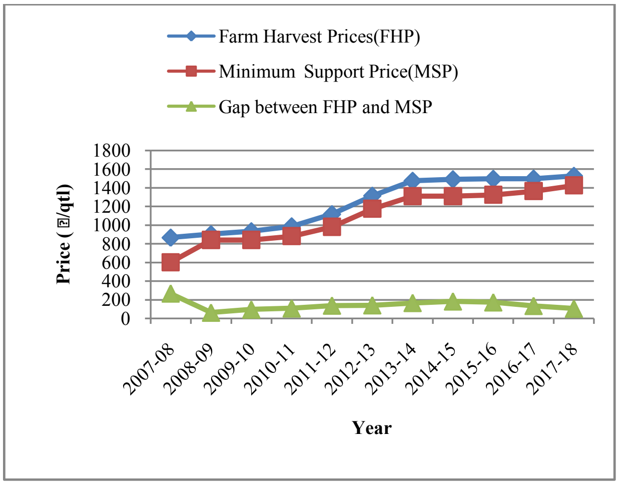

Fig. 6: FHP and MSP of maize crop

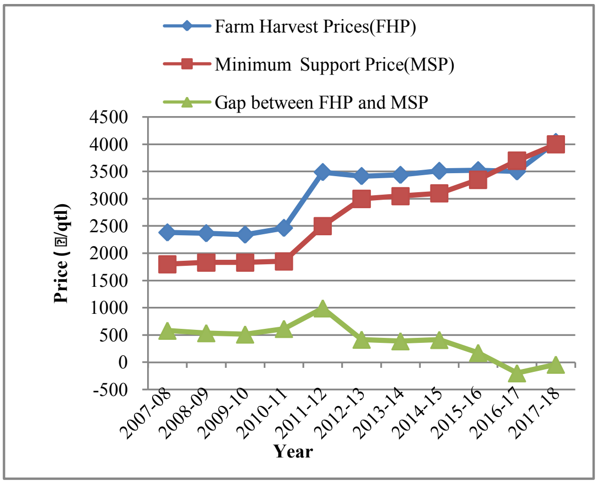

Fig. 7: FHP and MSP of rapeseed/ mustard crop

(like rice, wheat, gram, rapeseed/ mustard, maize, bajra, barley).

Impact of MSP on production of major food crops in Haryana during 2007-18

Impact of MSP on production of major food crops in Haryana are presented in Table 6. The numerical values of the linear lag function for food crops indicates that R^2 is significant at 1 per cent level and supports the results that variation in production of food crops is explained by the explanatory variable, *i.e.* previous year's minimum support prices of the food crops. The result revealed that 18 per cent variation in production of wheat, 69 per cent variation in production of rice, 56 per cent variation in production of bajra, 48 per cent variation in production of barley, 71 per cent variation in production of gram, 39 per cent variation in production of maize and 20 per cent variation in production of rapeseed / mustard is explained by independent variable *i.e.* lagged MSP. The elasticity for these variables is significant at 1 per cent level in case of production of food crops. The value of elasticity has found as 1.512, 1.060, -0.566, -0.084, -0.031, -0.012, 0.135 per cent indicating thereby that previous year price influences current year's production of major food crops (like rice, wheat, gram, rapeseed/ mustard, maize, bajra, barley).

Table 6: Impact of MSP on production of major food crops in Haryana during 2007-18

Crops	R^2	S.E of R	Linear regression equation
Wheat	0.18	808.20	$y = 9457 + 1.512x$
Rice	0.69	209.62	$y = 2663 + 1.060x$
Bajra	0.56	143.96	$y = 1489 + (-0.566)x$
Barley	0.48	7.04	$y = 206.7 + (-0.084)x$
Gram	0.71	16.03	$y = 152.5 + (-0.031)x$
Maize	0.39	4.81	$y = 37.39 + (-0.012)x$
Rapeseed/ mustard	0.20	188.44	$y = 97.49 + 0.135x$

y = Production x = MSP_{t-1}.

Impact of MSP on productivity of major food crops in Haryana during 2007-18

Impact of MSP on productivity of major food crops in Haryana are presented in Table 7. The numerical values of the linear lag function for food crops indicates that R^2 is significant at 1 per cent level and supports the results that variation in productivity of food crops is explained by the explanatory variable, *i.e.* previous year's MSPs of the food crops.

Table 7: Impact of MSP on productivity of major food crops in Haryana during 2007-18

Crops	R^2	S.E of R	Linear regression equation
Wheat	0.06	808.20	$y = 4082 + 0.33x$
Rice	0.03	201.45	$y = 2966 + 0.12x$
Bajra	0.23	130.74	$y = 1558 + 0.25x$
Barley	0.13	7.044	$y = 3095 + 0.39x$
Gram	0.03	238.47	$y = 730.1 + 0.05x$
Maize	0.26	413.71	$y = 1780 + 0.80x$
Rapeseed/ mustard	0.12	188.44	$y = 2951 + (-0.42)x$

y = productivity x = MSP_{t-1}.

The result revealed that 6 per cent variation in productivity of wheat, 3 per cent variation in productivity of rice, 23 per cent variation in productivity of bajra, 13 per cent variation in productivity of barley, 3 per cent variation in productivity of gram, 26 per cent variation in productivity of maize and 12 per cent variation in productivity of rape seed/ mustard is explained by independent variable *i.e.* lagged MSP. The elasticity for these variables is significant at 1 per cent level in case of productivity of food crops. The value of elasticity has found as 0.33, 0.12, 0.25, 0.398, 0.05, 0.80, -0.42 per cent indicating thereby that previous year price influences current year's productivity of major food crops (like rice, wheat, gram, rapeseed/ mustard, maize, bajra, barley).

CONCLUSIONS AND POLICY IMPLICATIONS

The gap analysis in which deviations of FHPs from MSPs of food crops results in positive deviations (FHP ruled higher than MSP) in most of cases in Haryana during 2007-18. In Haryana, higher demand due to more procurement for central part than supplies does not allow the market prices to fall below MSP. Market prices for bajra and barley rule lower than the MSP in some years during post harvest period and shoot up during the lean periods. The government intervention was very strong and did not allow the FHPs to move away from MSPs in a significant manner despite large marketed surplus. The increase in MSP over the previous year brought additional area under food crops, but the impact was nominal. From the results we conclude that impact of MSP on area is higher but there is lower impact of MSP on productivity of food crops. A higher rate of increase in the MSP of paddy over the previous year increased the area significantly under this crop. It may be concluded on the bases of above discussion that for bringing about the technological revolution, the price policy is a necessary condition but not a sufficient one. In Haryana, a large chunk of good quality land was shifted from pulses, oilseeds to paddy and wheat crops creating a serious imbalance in the demand and supply of several other agricultural commodities.

Introduction of Direct Payment Deficiency System (DPDS) for paying MSP guarantee for the farmers has to be initiated. Under this system, the farmers will directly get the amount, which is the difference between the Minimum Support Price (MSP) and the market price, when the market price falls below the MSP. The government of India may adopt the recommendation given by the National Commission for Farmers (NCF) that MSP should be at least 50 per cent more than the weighted average of cost of production. New technological mission on food crops should be started to promote the growth of food crops. In Haryana, procurement is effective only in rice and wheat crops. Policy should made availability of procurement machinery for all the food crops. Policy should provide proper warehouse facilities for increasing farmers income. The Cabinet Committee on Economic Affairs should increase in the Minimum Support Prices (MSPs) for all Kharif crops and to incentivise cultivation of pulses and oilseeds, Government should announced a more bonus on these crops, payable over and above the approved MSP. Swaminathan commission suggested to give farmers a minimum support price at 50 per cent profit above the cost of production classified as C2 by the Commission for Agricultural Costs and Prices (CACP).

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Comparative Economics of Neem Coated Urea Vis-a-Vis Normal Urea: Evidence from a Field-based Study in the Indian Context

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ABSTRACT

This article is an output of the late led investigation entitled 'Impact of Neem Covered Urea on Production, Productivity, and Soil Health in India' across six major agricultural states of India. A sample of 2200 farmers growing major crops using Neem Coated Urea (NCU) and Normal Urea (NU) under irrigated and un-irrigated conditions was selected randomly. Data was elicited for the agriculture year 2016-17 through a survey method. The per acre paid-out costs incurred by both NCU and NU users with respect to ploughing and sowing, seed /purchase of seedlings, organic/FYM, normal urea/neem coated urea, chemical fertilizers, plant protection chemicals, irrigation charges, harvesting & threshing charges, hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting), imputed value of family labour, hired labour (amount paid) and maintenance costs on assets were worked out by way of comparing the economics of NCU and NU usage. The results reveal that the total paid-out costs of paddy have slightly increased in respect of NCU, as compared to NU. However, the net returns received amount to ₹ 23,616/-per acre and ₹ 19,517/-per acre, respectively. As regards *tur*, per acre total paid-out cost works out to ₹ 12,695 for NCU as compared to NU at ₹ 12,149 with a net return of ₹ 6,155 and ₹ 6,916, respectively. The paid-out costs incurred on cultivation of Sugarcane amount to ₹ 36,384 for NCU, as against ₹ 33,193 in the case of NU. Similarly, in respect of Soybean, the comparative paid-out costs amount to ₹ 9,776 for NCU and ₹ 8,660 for NU; ₹ 12,312 for NCU, as against ₹ 13,203 for NU, as in the case of maize; ₹ 15,349 for NCU, as against ₹ 15,353 for NU with reference to jute. Whereas, the net returns on sugarcane cultivation amount to ₹ 81, 122 for NCU, as compared to NU at ₹ 69,144; ₹ 8,012 for NCU, as against ₹ 6,611 for NU in respect to soybean; as regards maize, the returns realized amount to ₹ 17,110 for NCU, compared to ₹ 13,809 for NU; as for as jute is concerned, the returns amount to ₹ 3,082 for NCU, and ₹ 3,965 for NU, respectively.

Highlights

- Mandatory production and distribution of NCU started from May 2015 by the GoI.
- NCU found to be cost-effective as compared to Normal Urea.
- NCU benefits are much higher than Normal Urea.

Keywords: Neem coated urea, Normal urea, Cost of Inputs, Input use, Market Price, Gross Returns

India has been experiencing a rapid economic growth and development in the relatively recent years, especially after the introduction of a new economic liberalization policy in the early 1990s. The serious economic and political crisis that India was facing in the mid-1960s led to the introduction of new agricultural policies with a focus on technological breakthrough innovations and the import of new agricultural technologies from abroad. And it was a fortunate coincidence for India that the mid-1960s was a period when new seed-fertilizer technologies had started making their

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entry into the tropical developing world especially in the northern Indian states such as Punjab and Haryana with suitable climatic conditions.

The most important factor which promoted the dissemination of new technologies was the spread of private tube-wells for groundwater exploitation. In this context, Malik and Shekhar (2007) argued that in the absence of any significant breakthrough in the agricultural production technology having been achieved in the last several years, achieving the desired levels of agricultural production in the short- to -medium run would require more concerted efforts towards bridging the crop productivity gaps attainable with the existing technologies. Thus, the new seed-fertilizer technologies, especially for wheat crop, started disseminating very rapidly in the northern India and within a decade or so, the country was able to attaining food self-sufficiency, excepting a few drought years. On the other hand, there has been a spectacular increase in fertilizer consumption in the country since the advent of Green Revolution in the mid-sixties. Further, a series of economic liberalization measures implemented after 1991 in the country, have largely contributed to an accelerated growth of the economy. Considering the importance of agriculture in meeting the increasing food grain requirements of an ever-growing population of the country, 'fertilizer', as an input in agricultural production, assumes a greater significance in terms of ensuring a sufficient food-grain production. In fact, it is important to note that this role has witnessed a comprehensive transformation of the traditional cultivation practice to modernization of agriculture. As the expansion of area under cultivation is not possible, arable land is declining (Venugopal, 2004), while soil is becoming increasingly deficient in many plant nutrients (Parama and Munawery, 2012) due to the intensive nature of agricultural production. Therefore, the use of fertilizers is vital to restoring soil fertility (FAI). However, an over use of fertilizers in general and urea in particular, over time, has affected the soil quality, resulting in a gradual reduction in the yield levels, across the country.

Fertilizer consumption has jumped from a less than million tons in the mid-1960s to 28 million tonnes by 2019-20. In fact, India ranks second in the world with respect to fertilizer consumption. Urea, one of the most prominent fertilizers, alone accounts for about 57 per cent of the total fertilizer consumption in the country. While fertilizer consumption, both in absolute terms and per hectare basis, has increased manifold over the years, the growth in the last few years has not been satisfactory (Malik and Shekhar, 2007). P. Mala (2013) has established that an increased fertilizer use efficiency leads to economy in the use of fertilizers, a reduction in the unit cost of production and prevention of af all in agricultural productivity. But, the pattern of fertilizer use appears distorted with a growing imbalance in the use of primary nutrients i.e., nitrogen (N), phosphorus (P), and potash (K). Current NPK use ratio is 7:2.7:1 as opposed to a desirable ratio of 4:2:1. Moreover, there exist huge variations in the fertilizer use across various states in the country. For instance, fertilizer use per hectare amounts to less than 10 kg in some of the North Eastern states such as Nagaland, as against 213 kg in Punjab or 262 kg in Telangana. Hence, there is a need for increasing per hectare fertilizer use in areas where there is a potential for growth in India. Likewise, there is a need for correcting the imbalance in the use of nutrients. An improper use of plant nutrients has led to multi-nutrient deficiency in the soils and the resultant soil health deterioration and stagnant crop yields. Recognizing the importance of plant nutrients, the Government of India, over the years,has taken various steps towards promoting a balanced use of fertilizers. The Task Force recommended the restoration of NPK use ratio at the macro-level through an increased use of nutrients P & K instead of reducing the intake of nitrogen.

It is a fact that about 82 per cent of nitrogen application in the country takes a place through urea. In order to increase the nitrogen-use efficiency of urea, the Government of India has made it mandatory to produce 100 per cent neem coated urea, including imported urea from June 2015. Neem coating results in as low release of urea, leading to a higher nitrogen use efficiency. Besides acting as a natural pesticide, neem also helps check the diversion of highly subsidized urea to non-agricultural uses. Further, in order to ensure a balanced use of fertilizers and reduce the consumption of urea, the Government of India decided to introduce a 45-kg bag of urea in place of 50-kg bags from 2018. Although the steps taken by the government so far appear to be well-intended, they have failed to promote a balanced use of fertilizers. Keeping this in background, the Impact of NCU on production, productivity, and soil health was carried out by the Government of India. The present article is part of the same project with the following objectives addressed:

1. To estimate the per acre input cost incurred by NCU and NU users with respect to different crops across the sample states.
2. To come up with a comparative economics picture of NCU and NU users across the sample states.

MATERIALS AND METHODS

During 2015 *Kharif* season, both NCU and NU were available in the market across the study area even before the government made the production (100%) and distribution of NCU mandatory throughout the country. Hence, the present study collected the data pertaining to two seasons viz., *Kharif* 2014 representing Normal Urea (NU) usage and *Kharif* 2015 representing Neem coated Urea (NCU) usage as part of comparing the economic benefits of NCU and NU usage among the farming community. The present article relied upon primary data collected from the selected states in India with the reference periods being *Kharif* 2014(NU) and *Kharif* 2015 (NCU). Both irrigated and rainfed crops accounting for highest urea usage in each of the selected states were considered for the study. For each crop, two districts were selected based on the area under the selected crops and their urea usage within the state. From each district, two *taluks/tehsils* were selected based on the same criterion. Within the selected taluks, two clusters comprising 3-4 villages each were selected for conducting the survey. A total of 50 farmers from each taluk were selected with the total farmers adding up to 100 from each district. Households were selected randomly for assessing the NCU fertilizer use and its impact on crop production. The households were classified into two categories -NCU users and non-users (those using Normal Urea) - mainly to examine the impact of NCU, as compared to NU. Further, an adequate care was taken to ensure that the selected crops were grown under chosen irrigated/ un-irrigated conditions in the state. Thus, a total of 200 (NCU/ Normal Urea) farmers for each crop were interviewed using a pretested structured questionnaire. An adequate care was taken with respect to the selection of a representative sample based on the operational land holding size. The information gathered from both primary and secondary sources were analysed, using a tabular format. The details of sample selection are presented in Table 1.

Table 1: State-wise crop coverage and the sample size

Sl. No./ Region	Crops	Irrigated/un irrigated	Sample Farmers	Total
South	**Karnataka**			
1	Paddy	Irrigated	200	**400**
2	*Tur*	Un-Irrigated	200	
West	**Maharashtra**			
3	Sugarcane	Irrigated	200	**400**
4	*Tur*	Un-Irrigated	200	
Central	**Madhya Pradesh**			
5	Paddy	Irrigated	200	**400**
6	Soybean	Un-Irrigated	200	
East	**Bihar**			
7	Paddy	Irrigated	200	**400**
8	Maize	Un-Irrigated	200	
North	**Punjab**			
9	Paddy	Irrigated	200	200
North-east	**Assam**			
10	Paddy	Irrigated	**200**	**400**
11	Jute	Un-Irrigated	**200**	
All India		Irrigated	1200	**2200**
		Un-Irrigated	1000	

Source: *Primary data.*

RESULTS AND DISCUSSION

Input costs incurred by NCU and NU users of paddy cultivation across the sample states

The details of inputs used and costs incurred on each input by NCU and NU users of paddy are presented in Table 2. A perusal of the table reveals a slight increase in the paid-out-costs (₹ 14,634 per acre)in respect of NCU as compared to NU (₹ 14,227 per acre)use at the overall level. This increase in the cost (₹ 407/- per acre) is distributed across different input costs incurred in the production process of paddy. Although, the prices of NCU are found to be slightly higher than NU, the total cost incurred shows a drastic reduction in respect of NCU. Similar is the case with the cost incurred on other fertilizers. Looking at the sample sates, the paid-out costs illustrate an increase for almost all the paddy farmers. From the sample states, the highest paid-out costs incurred are found in the case of Karnataka (₹ 29,712/- per acre for NCU in place of NU (₹ 27,729/- per acre), followed by Assam (₹ 12,781/- per acre for NCU over NU (₹ 12,090/- per acre), Bihar (₹ 12,009/- per acre for NCU against ₹ 11,086/- per acre in respect of NU), Punjab (₹ 10,432/- per acre for NCU in contrast to ₹ 10,209/- for NU), while the least paid-out costs have been noticed in the case of Madhya Pradesh (₹ 10,024/- per acre among NCU users, as compared to ₹ 9,013/- per acre towards NU). Interestingly, the cost of NCU shows a slight reduction for Punjab and Assam in respect of NCU in contrast to NU. In addition, the cost incurred on other fertilizers and PPCs also shows a slight reduction forAssam. While the cost on other chemical fertilizers is found to have increased, the cost on PPCs has declined with respect to Karnataka farmers.

A comparative economics of NCU and NU users of paddy cultivation across the sample states

In the Indian context, a steadily declining farmers' income is a common concern due to an increase in the input prices in comparison to after-harvest prices of agricultural commodities. An attempt has been made in this section to examine the profitability of paddy production with the use of NCU and/or NU. Profit measures namely, main product yield, by-product yield, gross income, net income, and benefit-cost ratio (BCR) on total paid-out costs have been worked out as part of a comparison. The average yield of main product and by–product, market price, marketing costs and net returns are worked out and presented in Table

Table 2: Per acre input cost incurred by NCU and NU users of paddy cultivation across the sample states (₹/Acre)

Sl. No	Particulars	Karnataka		Punjab		Madhya Pradesh		Bihar		Assam		Overall	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Ploughing and sowing charges (only machinery)	3731	3290	2340	2215	1387	1260	3071	2974	2534	2365	1992	1844
2	Seed cost/ purchase of seedlings	865	815	284	266	950	897	1597	1498	691	583	714	660
3	Organic/FYM	929	740	76	64	391	381	---	---	205	194	737	658
4	Urea/NCU	713	622	741	758	322	269	584	557	360	489	317	336
5	Chemical fertilizers (Other than Urea/NCU)	6797	6538	642	584	1187	1126	654	568	986	1073	1962	2005
6	Plant protection chemicals	4717	4742	1918	1897	686	643	752	656	223	231	1450	1482
7	Irrigation charges	172	120	457	690	108	125	412	315	650	579	211	208
8	Harvesting & threshing charges	3461	3315	1026	977	1950	1729	2027	1876	1697	1502	1353	1301
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	2970	2804	2385	2224	1572	1441	1201	1260	1964	1788	3302	3323
10	Imputed value of family labour	1760	1549	74	78	654	600	137	158	1974	1879	900	874
11	Hired labour (amount paid)	2388	2197	291	275	1130	996	1475	1150	1405	1323	1316	1207
12	Maintenance costs on assets used for the reference crop	1210	998	198	181	280	29	99	73	92	86	380	329
13	Total paid-out costs including imputed value of own labour	29712	27729	10432	10209	10024	9013	12009	11086	12781	12090	14634	14227

Table 3: Comparative economics of NCU and NU users of paddy cultivation across the sample states by respondents (₹/Acre)

Sl. No	Particulars	Karnataka		Punjab		Madhya Pradesh		Bihar		Assam		Overall	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Paid-out costs including imputed value of own labour	29712	27729	10432	10209	10024	9013	12009	11086	12781	12090	14634	14227
2	Main product yield in quintal	36	28	29	28	19	15	29	27	16	14	26	23
3	By product yield in quintal	67	62	0	0	33	25	31	38	32	28	41	38
4	Gross returns	51186	41233	41833	39740	21855	17914	29740	28042	18759	17186	38250	33744
5	Net returns	21474	13492	31401	29530	11237	8420	17730	16956	5978	5095	23616	19517
6	B.C. Ration on total paid-out costs	1.72	1.49	4.01	3.89	2.18	1.99	2.48	2.53	1.47	1.42	2.61	2.37

3. It is worth to note that the application of neem coated urea has increased the paddy yield (main product) to an extent of 26 quintals per acre in respect of NCU, as compared to 23 quintals per acre in respect of NU users at the aggregate. Similarly, paddy by-product has increased to an extent of 41 quintals per acre in the case of NCU in relation to NU users (38 quintals per acre). Across states, the highest main product yield is observed for Karnataka (36 quintals per acre)among NCU users in contrast to 28 quintals per acre in respect of NU users, followed by Punjab (29 quintal per acre for NCU in comparison to 28 quintals per acre inthe case of NU), Bihar (29 quintals per acre for NCU in contrast to NU (27 quintals per acre)), Madhya Pradesh (19 quintals per acre and 15 quintals per acre in respect of NCU and NU, respectively), and the least level of main product yield is observed for Assam state (16 quintals per acre for NCU as compared to NU (14 quintals per acre)). Similar results are observed for paddy by-product across the states,expecting Punjab and Bihar. From among the states, Karnataka accounts for the highest paddy by-product (67 quintals per acre for NCU in comparison to 62 quintals per acre for NU) while the least by-product yield is accounted by Assam (32 quintal per acre for NCU, as against 28 quintals per acre among NU users).

In terms of gross returns, NCU farmers have realized highest gross return to the tune of ₹ 38,250/- per acre as compared to ₹ 33,744/- per acre in respect of NU farmers. From among the states, the highest gross returns are noticed for Karnataka state to the tune of ₹ 51,186/- per acre among NCU farmers as compared to ₹ 41,233/- per acre in respect of NU users, followed by Punjab (₹ 41,833/- per acre for NCU as compared to NU farmers (₹ 39,740/- per acre), Bihar (₹ 29,740/- per acre for NCU farmers, as opposed to ₹ 28,042/- per acre for NU users), Madhya Pradesh (₹ 21,855/- per acre for NCU in comparison to ₹ 17,914/- per acre for NU users), and Assam (₹ 18,759/- per acre for NCU in contrast to ₹ 17,186/- per acre among NU users). Interestingly, the average net returns of NCU users amount to ₹ 23,616/- per acre for NCU as compared to ₹ 19,517/- per acre for NU farmers, the highest among other states. Further, it is worth mentioning that the main product has increased for almost all the paddy sample states in the country. However,excepting Bihar and Punjab, the by-product turnover also shows an increase for all other States. Accordingly, the net returns have also increased forthe entire paddy sample States.

As regards net returns, the highest net return is noticed in respect of Punjab (₹ 31, 401/-per acre for NCU users as against ₹ 29,530/- per acre for NU users), followed by Karnataka (₹ 21,474/- per acre for NCU in contrast to ₹ 13,492/-per acre for NU users), Bihar (₹ 17,730/-per acre for NCU, as against NU users (₹ 16,956/-per acre)), Madhya Pradesh (₹ 11,237/-per acre for NCU in comparison to NU users (₹ 8,420/-per acre), and the least net return from paddy production is found realized by Assam farmers (₹ 5,978/-per acre for NCU users,as compared to NU users (₹ 5095/-per acre), respectively. The highest net return realized by Punjab paddy farmers could be attributed to the application of NCU and the adoption of advanced agricultural technologies in paddy production in relation to other states. The BCR is also highest to the extent of 2.61 in respect of NCU farmers as compared NU users (2.37). These findings are in conformity with the results of the study conducted by Suresh (2001), Jadhav *et al.* (2006), Naik (2010) and Inder Pal Singh and Grover (2011). Across the states, the BCR is observed highest in the case of Punjab among NCU (4.01) farmers, as against 3.89 in respect of NU, followed by Bihar (2.48 for NCU, as compared to 2.53 in respect of NU farmers), Madhya Pradesh (2.18 for NCU as compared to 1.99 for NU farmers), Karnataka (1.72 for NCU and 1.49 for NU), and the lowest is observed in the case of Assam (1.47 for NCU,as against 1.42 in respect of NU farmers), implying that application of NCU is a profitable intervention.

Input costs incurred by NCU and NU users for *tur* cultivation across the sample states

The major inputs and costs incurred by farmers in the cultivation of *tur* include ploughing and sowing charges, seed cost/purchase of seedlings, organic/ FYM, normal urea/neem coated urea, chemical fertilizers, plant protection chemicals, irrigation charges, harvesting & threshing charges, hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting), imputed value of family labour, hired labour (amount paid) and maintenance costs on assets. Table 4 illustrates the details of per acre inputs used by *tur*-farmers in Karnataka and Maharashtra states. The results reveal that, on an average, the total paid-out costs incurred by tur-farmers works out to ₹ 12,695/- per acre for NCU, as against ₹ 12,149/- per acre for NU. The incremental costs in the paid-out costs are distributed across variables used in the production of tur, excepting organic fertilizers/ FYM, harvesting and threshing charges, and imputed value of family labour. Across states, the paid-out costs of *tur* are found relatively the same in respect of Karnataka, whereas in the case of Maharashtra, the paid-out costs are found to have increased from ₹ 9,638/- per acre to ₹ 10,692/- in the case of NCU. The marginally increased costs observed in respect of NCU are mainly due to an increase in ploughing and sowing charges and costs incurred on chemical fertilizers (other than urea), whereas, in other cases, the costs are found to be almost the same for NCU and NU users.

A comparative economics of NCU and NU users for *tur* cultivation across the sample states

A per acre comparative economics of NCU and NU users for *tur* cultivation across the sample states is presented in Table 5. A remarkable decrease in tur yield is observed in respect of main product

Table 4: Per acre input costs incurred by NCU and NU users for *tur* cultivation across the sample states (₹/Acre)

Sl. No.	Particulars	Karnataka		Maharashtra		Overall	
		NCU	NU	NCU	NU	NCU	NU
1	Ploughing and sowing charges (only machinery)	2151	2034	2018	1761	2040	1923
2	Seed cost/ purchase of seedlings	417	346	717	596	451	380
3	Organic/FYM	1153	1159	490	369	1964	2054
4	Urea/NCU	268	226	268	270	268	248
5	Chemical fertilizers (Other than Urea)	1340	1332	1222	1050	1281	1191
6	Plant protection chemicals	1610	1751	958	847	1171	1202
7	Irrigation charges	16	16	201	167	223	198
8	Harvesting & threshing charges	1640	1721	1579	1593	1649	1702
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	710	704	810	737	733	724
10	Imputed value of family labour	1108	1180	1094	1001	947	1025
11	Hired labour (amount paid)	852	939	1003	963	1598	1027
12	Maintenance costs on assets used for the reference crop	230	191	335	283	370	475
13	Total paid-out costs including imputed value of own labour	10902	10977	10692	9638	12695	12149

Table 5: Comparative economics of NCU and NU users for *tur* cultivation across the sample states by respondents (₹/Acre)

Sl. No.	Particulars	Karnataka		Maharashtra		Overall	
		NCU	NU	NCU	NU	NCU	NU
1	Paid-out costs	10902	10977	10692	9638	12695	12149
2	Main product yield in quintal	2	3	4.03	4.28	3.60	2.65
3	By product yield in quintal	2	3	1.75	1.72	1.90	2.30
4	Gross returns	17027	19182	37272	23503	18850	19065
5	Net returns	6285	8206	26580	13865	6155	6916
6	B.C. Ration on total paid-out costs	1.56	1.75	3.49	2.44	1.48	1.57

Table 6: Per acre input costs incurred by NCU and NU users for cultivation of various crops across the sample states (₹/Acre)

Sl. No.	Particulars	Maharashtra		Madhya Pradesh		Bihar		Assam	
		Sugarcane		Soybean		Maize		Jute	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Ploughing and sowing charges (only machinery)	4200	3860	601	516	1179	1111	1146	1131
2	Seed cost/ purchase of seedlings	5576	5107	2199	1860	3600	3772	268	234
3	Organic/FYM	2665	2220	174	165	---	---	527	704
4	Urea/NCU	1602	1720	114	87	1131	1291	249	304
5	Chemical fertilizers (Other than Urea/NCU)	5833	4841	1206	1233	953	1217	681	553
6	Plant protection chemicals	1374	1031	667	619	486	450	126	137
7	Irrigation charges	2469	2270	11	2	849	860	0	0
8	Harvesting & threshing charges	0	0	832	709	1947	2218	7000	7000
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	3702	3453	341	309	332	307	363	363
10	Imputed value of family labour	4540	4329	1334	1289	349	390	1790	1865
11	Hired labour (amount paid)	2442	2528	1995	1735	1203	1323	1816	1741
12	Maintenance costs on assets used for the reference crops	1981	1832	301	138	281	265	44	46
13	Total paid-out costs including imputed value of own labour	36384	33193	9776	8660	12312	13203	15349	15353

as well as by-products for both the states due to successive drought conditions in the sample study area. A perusal of the table also shows that the total paid-out costs of *tur* cultivation on NCU are slightly higher (₹ 12,695/- per acre), as compared to NU (₹ 12,149/-per acre) users. Looking at the yield structure, the average main product yield per acre of *tur* cultivation amounts to 3.60 quintals per acre while that of by-product to 1.90 quintal per acre for NCU users, as compared to NU users (2.65 quintals per acre of main product and 2.30 quintal per acre of by-product) at the aggregate. It also clearly reflects that the application of NCU enhances the yield levels of *tur*. Accordingly, the average gross return amount to ₹ 18,850/- per acre in respect of NCU in comparison to NU users (₹ 19,065/-per acre). From among the selected states, the highest gross return is accounted for Maharashtra (₹ 37,272/-per acre for NCU in relation to ₹ 23,503/-per acre among NU users), followed by Karnataka (₹ 17,027/-per acre for NCU, as compared to NU users (₹ 19,182/-per acre).

Tur output is found to be better for Maharashtra for both the NCU and NU users, depending upon the severity of drought in these states. Further, a better price is also observed for *tur* in respect of Maharashtra among NCU users, and accordingly, they have earned better net returns (more than four times) as compared to NU farmers in Karnataka. The Karnataka farmers are found to have incurred a loss of ₹ 1,972/- per acre for NCU, as compared to NU users. Notably, *tur* production has increased by 0.95 quintal per acre for NCU, as compared to NU users, while by-product per acre has decreased from 2.30 quintals for NU to 1.90 quintals for NCU. On the contrary, the net returns have decreased due to a fall in the prices of *Tur.* The BCR is also higher for Maharashtra for NCU (3.49), as compared to 2.44 in the case of NU users, followed by Karnataka (1.56

for NCU, as compared to 1.75 for NU) and lowest BCRis noticed in the case of overall farmers.

Input costs incurred by NCU and NU users for sugarcane, maize, soybean and jute

The details of input costs incurred per acre of sugarcane, maize, soybean and jute crops are presented in Table 6. It is clearly revealed from the table that the total paid-out costs incurred on sugarcane crop in the case of Maharashtra is highest (₹ 36,384/- per acre) for NCU farmers, as against ₹ 33,193/- in respect of NU users, and the increase in costs is distributed across all inputs used in the production process. Interestingly, there is a slight reduction noticed in the cost of NCU, as compared to NU. Similarly, in the case of Madhya Pradesh, the paid-out costs incurred on soybean crop are highest (₹ 9,776/-) for NCU in contrast to ₹ 8,660/- for NU users. There is a meager increase in the cost of NCU, as compared to NU users, while a slight decrease is observed in the costs of other chemical fertilizers during post adoption of NCU. However, the increased costs are distributed across different inputs used by NCU farmers. As regards maize crop in respect of Bihar, the paid-out costs have shown an increasing trend in the case of NCU users in relation to NU users, while the increased costs (though not substantial) (₹ 891/- per acre) are found distributed across different inputs. Regarding jute in the case of Assam, the paid-out costs, along with other inputs, are found relatively the same for NCU (₹ 15,349/- per acre) and NU users (₹ 15,353/-per acre).

Comparative economics of NCU and NU users for sugarcane, maize, soybean and jute

A comparative economics of NCU and NU users for sugarcane, maize, soybean and jute are presented in Table 7. Although the additional costs have increased due to the application of NCU, the output has shown an increase both in terms of main product (about 53 quintals/per acre) and by-product (8.30 quintals/ per acre), as compared to NU users (49.30 quintals of main product per acre and 4.70 quintals per acre of by-product). Accordingly, the increase in gross returns and net returns works out to ₹ 1,17,506 and ₹ 81,122/- per acre for NCU, as against ₹ 1,02,337 and ₹ 69,144/- per acre for NU users. Consequently, the production of both the main output and by-products have found increased in the case of NCU farmers. The increase in output and by-products may not be directly attributed to the application of NCU alone. The BCRs are also found higher (3.23) for NCU in comparison to NU (3.08). The per acre total paid out costs for soybean production in respect of Madhya Pradesh amounts to ₹ 9,776/- per acre for NCU users in contrast to NU users (₹ 8,660/- per acre). Accordingly, the average main product yield works out to 10.16 quintals per acre and by-product yield to 14.33 quintals per acre for NCU farmers,as compared to 8.98 quintals and 10.20 quintals per acre respectively, for NU farmers, which is relatively lower than that of NCU farmers. The return structure for soybean clearly reflects that the gross returns per acre are highest at ₹ 17,788 for NCU users, as compared to that of NU users (₹ 15,271/-per acre) (Table 7), thereby depicting positive net returns for both the users. The net returns on NCU amount to ₹ 8,012/ - per acre and that of NU to ₹ 6,611/-per acre. The BCR is also higher in the case of NCU users (1.82) as against NU users(1.76). The higher BCR could be attributed to higher levels of yield, lower paid-out costs, and maximum price received for the quality product. Similar results have been observed by Jitendra Singh *et al.* (2006), Sujata *et al.* (2006), Waykar *et al.* (2006).

The per acre paid-out costs incurred on NCU and

Table 7: Comparative economics of NCU and NU users for cultivation of various crops across the sample states (₹/Acre)

Sl. No.	Particulars	Maharashtra		Madhya Pradesh		Bihar		Assam	
		Sugarcane		Soybean		Maize		Jute	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Total paid-out costs	36384	33193	9776	8660	12312	13203	15349	15353
2	(Main product yield in quintal)	53.29	49.30	10.16	8.98	24	23	6	7
3	By product yield in quintal/ tons)	8.30	4.70	14.33	10.20	29	35	8	8
4	Gross returns (₹)	117506	102337	17788	15271	29421	27012	18820	19398
5	Net returns (₹)	81122	69144	8012	6611	17110	13809	3082	3965
6	B.C. Ration on total paid-out costs	3.23	3.08	1.82	1.76	2.39	2.05	1.23	1.26

NU for maize production in respect of Bihar are presented in Table 7. A perusal of the table reveals that the total paid out costs of maize production with NCU use amount to less than that of NU users. The total paid-out costs for NCU works out to ₹ 12,312/- per acre, as against ₹ 13,203/-per acre for NU users, an indication that the NCU application not only enhances yield levels but also reduces the total paid-out costs. Looking at the yield levels, it is observed that per acre average yield with NCU works out to 24 quintals per acre for main product and that of by-product to29 quintals per acre, as against 23 quintals per acre for main product and that of by-product to 35 quintals per acre with NU use. The gross returns and net returns structure on maize production for Madhya Pradesh clearly reveals that per acre gross and net returns higher at ₹ 29,421, and ₹ 17,110 for NCU farmers as compared to NU farmers (₹ 27,012 and ₹ 13,809/- per acre), respectively. The BCRs are found positive at 2.39 and 2.05, respectively. It is worth to note that the incremental benefit on net return is mainly due to the application of NCU (₹ 3301/- per acre). There is an increase of one quintal in the case of main product yield and a decrease of six quintals in the case of by-product yield, post the adoption of NCU, as compared to NU.

The per acre paid-out costs for jute production in respect of Assam amounts to ₹ 15,349 for NCU farmers,as compared to NU (₹ 15,353/- per acre) users. Accordingly, the average yield of main product works out to six quintals and that of by-product to eight quintals per acre, respectively for NCU users in comparison to NU users (7 quintals of main product and 8 quintals of by-product). Looking at the structure of gross and net returns, the average gross returns and net returns amount to ₹ 18,820/-per acre and ₹ 3,082/- per acre in the case of NCU users, as against ₹ 19,398/-per acre and ₹ 3,965/-per acre in respect of NU users. Similarly, the BCR works out to 1.23 for NCU users, as against 1.26 in the case of NU users.

In fact, there is a decrease observed in the main product to the extent of one quintal per acre for NCU users, as compared to NU users. However, the quantity of by-product has remained the same for both the users. As a result, there is a decrease in the net returns to the extent of ₹ 883/- per acre for NCU users, as against NU users.

Diversion of NU and NCU towards others, other than crop purposes

All the sample farmers from the study were asked about the usage of NCU for other than crop production purposes. It has been found during the survey that a very few farmers have used NU in cattle and fishery feed preparation, mixing with milk to enhance the fat content etc., with a very minute quantity (0.1gm/ kg). However, post introduction of NCU, none of the sample farmers has used has NCU for any purpose other than crop production.

CONCLUSION

After observing the benefits of NCU over NU, the Government of India has made mandatory the production (100%) and distribution of NCU throughout the country from June 2015. Farmers have applied higher quantities of NCU in place of NU due to their ignorance about the slow releasing property of NCU and its benefits. Since both NCU and NU were available in the market before *Kharif* 2015, a few farmers across the country were using NCU, however, its usage has increased only after *Kharif* 2015. Therefore, the usage of total fertilizers and NU/NCU fertilizers was more or less the same during the study period. Contradictorily, the incidence of pest and disease attacks was on the decline. Overall, the total paid-out costs have slightly increased post NCU use as compared to NU, however, the increased costs were spread across different inputs used in the production process of these reference crops. Although the prices of NCU are slightly higher than NU, the total costs for NCU users show a drastic reduction. Whereas, both the main product and by-products have increased, leading to an increase in the net returns with NCU usage. Considering the benefits of NCU over NU, the decision of the government seems to be right and in the direction of Sustainable Development Goals (SDGs) of the country. More importantly, NCU usage helps the farming community reduce the production costs besides enhancing returns.

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Economics of Marketing of Apple Crop and the Problems Faced by Growers in Himachal Pradesh

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ABSTRACT

In view of India's potential competitiveness in apple crop in the international market, it is imperative to understand the dynamics of domestic trade in apple. In this study, marketing and price-spread patterns of apple crop in the state of Himachal Pradesh have been examined. A few policy interventions have been suggested for promoting apple crop in the state. The present study has been carried out in the two purposively selected blocks i.e., Banjar and Naggar of Kullu District of Himachal Pradesh by taking representative sample of 70 farmers. The produce has been found to be marketed through four channels and maximum i.e., about 59 percent has been disposed off through channel B (Producer-primary wholesaler-secondary wholesaler-retailer- consumer). Comparison between different channels revealed the highest share in consumer rupee in Channel D (Producer- retailer-consumer) i.e., 73.95 per cent and marketing efficiency has also been found to be highest in channel D i.e. 2.84 which means smaller the channel more profitable it is. Lack of good infrastructure and availability of skilled labour were found to be the major problems faced by the apple growers in the study area.

Highlights

- This study highlights that out of the various channels adopted by the farmers Producer-primary wholesaler-secondary wholesaler-retailer- consumer was the most favored channel, though its marketing efficiency was found to be low. Out of total production of apple a loss of about two per cent was observed due to lack of better cold storage facility.

Keywords: Marketing channels, efficiency, problems, apple

Horticulture sector has emerged as a driving force for agricultural development in India. The sector is the most profitable venture for all farming activities, as it provides ample employment opportunities and scope to raise income of the farming community in the country. Besides, the sector has tremendous potential to push overall agricultural growth above the country's targeted 4 per cent level (Bahadur, 2010). Realizing these potentials, the government of India has started putting greater thrust for the development of horticultural sector after sixties in order to exploit the country's vast potential and to generate the much needed value addition.

Horticulture development in Himachal Pradesh is an economic necessity. The niche advantages for fruits have in the past been exploited by the growers, wherever natural conditions, socio-economic and institutional environments were favorable. The state of Himachal Pradesh being primarily a temperate hilly state is known for the production of commercial temperate fruits crops (Kashirsagar, 2006) that includes apple, peach, plum, apricot, walnut, strawberry and cherry etc. and among these apple is grown at the largest area and most preferred among the fruit growers in the state (Kumar *et al.* 2007). Horticulture sector

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covered 25431 thousand hectares of land in 2017-18, accounting for 8.5 percent of the gross cropped area of the country, with production of 311714 thousand metric tonnes (NHB, 2018). In Himachal Pradesh, area under fruit crops crops has been found to be 230.85 thousand hectares with the total production of 565.31 thousand metric tonnes out of which apple crop covers the area of 111.90 thousand hectares with the production of 446.57 thousand metric tonnes (Anonymous, 2018). Apple, the most dominant fruit of Himachal Pradesh, contributes around 57% of the total area under tree crops (Randev 2005) and more than 88 per cent of the total quantum of horticultural production (Kanwar and Nadda, 1984).

Kullu district of the Himachal Pradesh has become famous for production of apple. Greater emphasis is being laid down on this sector because geographical features and climatic conditions prevailing in the district are ideally suited for fruit farming. Among all the fruits grown in Kullu, apples are most widely grown and represent commercially the most important fruit crop of the district. The area under cultivated apple in Kullu district has increased significantly from 8573 ha during 1975-1976 to 26794 ha in 2017-2018 and apple production has increased from 62931 MT in 1975-1976 to 78948 MT in 2017-2018 (Anonymous, 2019).

Marketing is basically the process of movement of goods from produces to consumer at the desired time, place and form. The marketing system for apple is therefore, of utmost importance for those growers who specialize in apple production and of great importance to all those people who are concerned with the producer's share in the consumer's price. New market players have to be invited in, resources found for investments, change in policy and support systems from the government and building capacities in individuals and institutions for effective and remunerative participation in the value chain (Naqash, 2018). The extent of profitability of an enterprise also depends upon the efficiency of the marketing system. The expansion in the area and production alone is not an indicator of enhanced income, but its efficient marketing management is equally important to ensure better returns from the produce. The orchardist's are interested in better prices of their produce while consumers expect the availability of produce at reasonable prices. India faces a supply gap in its domestic apple market due to the increasing demand from the growing middle class (Ali, 2018). For achieving the conflicting objectives marketing system has to play a crucial role. It thus, becomes pertinent to review and analyze this farm activity.

Apple is being grown in nine districts of the state and the present study has been undertaken in the Kullu district because of the significant contribution of horticulture sector in improving the livelihood of the people in the district. Quite a few studies have been conducted in the past on the economic aspect of marketing of apples in the state, but apple industry is well established and dynamic in character, hence there has been a need to revalidate the economic indicators from time to time.

Objectives, Data Sources and Methodology

This study has been carried out in order to access the marketing performance of the apple crop with following specific objectives: (i) to estimate the marketed surplus and marketable surplus, (ii) to assess the value of different marketing functions, (iii) to identify the different marketing channels of apple crop and (iv) to estimate the marketing efficiency of identified marketing channels

Purposive sampling was adopted to select the study area i.e. Kullu district of Himachal Pradesh because of its significant contribution with respect to area and production of apple in the state, simultaneously providing fruitful employment to the families involved in apple cultivation. At the first stage 2 blocks namely Banjar and Naggar blocks were selected on the basis of highest area under apple by adopting probability proportion method. At the second stage 5 villages from each block were randomly selected. At the third stage a sample of about 7 apple growers from each selected village were selected by adopting probability proportion method in such a way that the total samples of the respondents were restricted to about 70. For the analysis of data the total respondents were divided into four classes according to the size of their land holdings, viz., marginal (<1 ha), small (1-2 ha), semi medium (2-4 ha) and medium farmers (>4 ha).

MARKET ANALYSIS

Marketing Costs

The total costs, incurred on marketing by the farmers and of the various intermediaries involved have been calculated as follows:

$$C = C_F + C_{mi}$$

Where, C = Total cost of marketing, C_F = Cost paid by the farmers and C_m = Cost incurred by middlemen,

Marketing Margin

Marketing margin of middleman calculated as the difference between the total payments (marketing cost + purchase price) and receipts (sale price) of the middlemen and calculated as follows.

$$A_{mi} = P_{Ri} - (P_{pi} + C_{mi})$$

Where, A_{mi} = Absolute margin of middlemen, P_{Ri} = Total value of receipts per unit (sale price), P_{pi} = Purchase value of goods per unit and C_{mi} = Cost incurred on marketing per unit

Price spread

Generally the economic efficiency of the marketing system is measured in terms of price spread. The smaller the price spread, the greater the efficiency of marketing system. Price spread refer to the difference between the price paid by the consumer and price received by the producer.

Producer's price

The net price received by the orchardist has been calculated by deducting the marketing costs borne by the producers from the original price paid to the producers by the commission agent/ wholesaler and is calculated as given below:

$$P_F = P_S - P_C$$

Where, P_F = Net price received by the producer, P_S = Producer's selling price and P_C = Marketing cost incurred by the producers.

Producer's share in consumer's rupee has been worked as under

$$P_S = (P_F / P_r) \times 100$$

Where, P_s = Producer's share in consumer's rupee, P_F = Price received by farmer per unit and P_r = Retail price per unit/ Consumer's purchase price

Marketing efficiency of the marketing channels

In case of marketing channels, the marketing efficiency is concerned with the movement of goods from producer to consumer at the lowest possible cost consistent with the provision of services desired by the consumers. The marketing efficiency of various channels in the study area has been computed by using Acharya's method, as under:

$$\text{ME} = \frac{\text{RP}}{\text{MC} + \text{MM}} - 1$$

Where, ME = Marketing efficiency, RP = Retailer's price, MC = Total marketing costs and MM = Total marketing margins

RESULTS AND DISCUSSION

Marketable and Marketed Surplus

In Kullu district more than 99 per cent of produce of an average farm is meant for the purpose of sale in the market. This amount requires the proper marketing arrangements. The marketed surplus primarily depends upon economic consideration like size of holdings, total production and the other factors like size of family and post harvest losses. For increasing marketed surplus, therefore, total production needs to be enhanced and post harvest losses need to be minimized. Of the total average production, the marketable surplus accounted for 99.21 per cent and on-farm consumption including gifts was found to be 0.8 per cent on overall basis.

The percentage of marketable surplus varied from 98.22 per cent on marginal farms to 99.73 per cent on medium farm. The total marketed surplus varied from 97.94 per cent on small orchards to 99.32 per cent on medium orchards with 97.63 per cent at an overall level. The market losses were estimated to be 1.57 per cent on an average and it varied from 0.95 per cent on small orchards to 1.58 per cent on marginal orchards. The boxes sold had standard weight of 22 kg apples in all farm categories (Table 1).

Table 1: Average production, family requirement and marketed surplus of apple in the study area (Boxes/farm)

Items	Farm Size				
	Marginal	Small	Semi medium	Medium	Overall
Area (ha)	0.4	0.9	2.07	4.29	1.02
Total production	392 (100)	904 (100)	2033 (100)	4140 (100)	1008 (100)
Total consumption	3 (0.76)	5 (0.55)	5 (0.25)	5 (0.12)	4 (0.4)
Gifts	4 (1.02)	5 (0.55)	4 (0.2)	6 (0.14)	4 (0.4)
Total marketable surplus	385 (98.22)	894 (98.89)	2024 (99.56)	4129 (99.73)	1000 (99.21)
Losses	6 (1.58)	9 (0.95)	9 (0.44)	17 (0.41)	16 (1.57)
Total marketed surplus	379 (96.63)	886 (97.94)	2015 (99.11)	4112 (99.32)	984 (97.63)

Figure in the parentheses is percentage to the total.

Table 2: Farm category wise cost of picking and assembling

Farm size	Quantity to be picked per farm (Qtls)	Total Cost (₹)	Total cost/ Qtls (₹)	Cost/ ha (₹)
Marginal	98.09	6866.30	70.00	17189.46
Small	226.04	14384.76	63.64	16051.77
Semi medium	508.14	39522.00	77.78	19138.14
Medium	1035.00	65863.64	63.64	15369.55
Overall	252.03	17450.88	69.24	17120.22

Marketing functions

Various marketing functions are performed by the apple growers for marketing the produce. The product has to be prepared for the market which involves picking, assembling, grading, packing, transportation, loading/ unloading, storage etc. All these factors have been found to be important determinants of prices which apple fetch in the market, and great care has to be ensured at every step. Any carelessness at any stage in marketing channel may lower the prices and hence affect net returns adversely.

Harvesting

Picking of apples at the correct time is essential to ensure its quality production and maximize storage life. The stage of picking also depends on the time lag between the picking and expected arrival of the fruit in the market. Apples are very susceptible to bruising and other forms of mechanical injuries and therefore should be handled very carefully. Damage from rough handling will accelerate deterioration, thus reducing the value of the produce.

Table 2 shows cost of picking and assembling the apple fruit category-wise on per farm basis and per hectare basis. This table shows that overall cost of picking and assembling per quintal was worked out to be ₹ 69.24, whereas category-wise cost of picking and assembling per quintal was found to be ₹ 70.00, ₹ 63.64, ₹ 77.78, ₹ 63.64 rupees for marginal, small, semi medium and medium farm category respectively.

Grading

After picking the fruit grading is the next important marketing function. Apple is graded according to size and quality of the fruit. Apple is classified into six size grades and three quality grades. The size grades are; super large, extra-large, medium, small, extra-small and pitto. These size grades are further classified into three quality grades. These are; extra-fancy (grade-A), fancy (grade-B), standard (grade-C) and culls. Facilities for mechanical grading of fruit also exist in apple growing areas.

Packing

Packaging is very useful function in the marketing. For commodities like apples which are perishable, fragile in nature and transported to distantly located markets all over the country needs a special type of container for packaging which can protect and preserve its quality during transportation and handling. Good quality fruit has been found to be normally packed either in wooden boxes or in the corrugated fibre board carton (cfb cartons) with pulp trays and low grade fruit is packed in gunny bags.

Category wise cost of grading and packing the apple fruit has been given in Table 3 which has shown that overall cost for picking and assembling per quintal of apple was found to be ₹ 45.16, whereas category- wise cost of picking and assembling was found to be ₹ 44.87, ₹ 48.79, ₹ 43.33, ₹ 41.54 rupees per quintal for marginal, small, semi medium and medium farm category respectively.

Table 3: Farm category wise cost of grading and packing

Farm size	Quantity to be graded and Packed (Qtls)	Total Cost (₹)	Cost/ Qtls (₹)	Cost/ ha (₹)
Marginal	98.09	4401.44	44.87	4401.44
Small	226.04	11027.82	48.79	11027.82
Semi medium	508.14	22019.40	43.33	22019.40
Medium	1035.00	42992.31	41.54	42992.31
Overall	252.03	11382.91	45.16	11382.91

Transportation

Transportation is another important marketing function which adds place utility to produce. The average transportation cost from orchard to fruit marketing functionary has been worked out as shown in table 4.

The pooled transportation cost per box was worked out to be ₹ 89 for channel A (Producer – wholesaler – retailer – consumer), ₹ 29 for channel B (Producer – primary wholesaler – secondary wholesaler – retailer – consumer), ₹ 29 for channel C (Producer– Pre harvest contractor – Primary wholesaler– secondary wholesaler – retailer – consumer) and ₹ 28 for channel D (Producer-retailer-consumer). The table shows that minimum transportation cost was found for channel D as it is the shortest channel i.e. producer to retailer to consumer, while transportation cost was found to be maximum for channel A i.e. producer to wholesaler to retailer to consumer as the produce is transported to distant market on trucks or jeeps.

Marketing Channels

Marketing comprises of movement of apples from producer to ultimate consumer. In this chain various agencies like growers, pre-harvest contractors, wholesalers, retailers, etc, are engaged. This chain of intermediaries/ functionaries is called the marketing channel. The following channels have been identified as important channels in the study area

- Channel A : Produce-wholesaler-retailer-consumer
- Channel B : Producer-primary wholesaler-secondary wholesaler-retailer-consumer
- Channel C : Producer -Pre harvest contractor-Primary wholesaler- Secondary Wholesaler-retailer- consumer
- Channel D : Producer-retailer-consumer

Table 5 shows different marketing channels used by the orchardist to dispose off their produce. Generally four channels were found to be adopted by the orchardist in the study area. It was observed from the analysis that about 36 per cent of the orchardist were found to be disposing of the produce through channel A, 87 per cent through channel B, 13 per cent through channel C and 26 per cent through channel D on overall basis. It can be seen that maximum percentage of orchardist were found to be disposing of their produce through channel B i.e., Producer - Primary wholesaler - Secondary wholesaler - retailer- consumer. Similar marketing channels of apple crop has been found

Table 4: Channel wise transportation cost (₹/Box)

Channel	Farm size									
	Marginal		Small		Semi medium		Medium		Pooled	
	No. of Boxes	Cost /Box	No. of Boxes	Cost /Box	No. of Boxes	Cost /Box	No. of Boxes	Cost/ Box	No. of Boxes	Cost /Box
A	96	90	198	88	251	89	215	87	165	89
B	208	30	500	28	1229	27	2663	30	586	29
C	57	30	135	28	409	27	875	30	177	29
D	19	27	53	29	126	25	358	30	63	28

by Kashyap and Guleria (2015) in Mandi district of Himachal Pradesh.

Table 5: Farm category wise marketing channels adopted by the orchardists (number)

Farm size	Marketing Channels			
	A	B	C	D
Marginal	15 (52)	25 (86)	4 (14)	5 (17)
Small	10 (37)	24 (89)	3 (11)	8 (30)
Semi Medium	0 (-)	9 (82)	2 (18)	3 (27)
Medium	0 (-)	3 (100)	0 (0)	2 (67)
Overall	**25 (36)**	**61 (87)**	**9 (13)**	**18 (26)**

Figures in parentheses indicates percentage to total households.

Mode of sale

Table 6 has shown the mode of sale adopted by the orchardist in the study area. It has been observed from the analysis that the percentage of the orchardists who disposed off their produce by themselves in the regulated markets ranged between 86 per cent in marginal category to 100 per cent in medium category and it was found out to be 87 per cent for overall data. The range of the orchardists who sold off their produce through pre harvest contractors was found to be between 14 to 18 per cent among different categories and about 13 per cent for the overall data. Maximum percentage i.e. about 18 per cent of the semi medium orchardist were found giving their orchards to pre harvest contractors which shows less managerial capacity amongst semi medium orchardist than other categories of the orchardist.

Table 6: Farm category wise Mode of Sale adopted by the orchardist (Number)

Farm size	Through Pre-harvest contractor	By Themselves	Total
Marginal	4 (14)	25 (86)	29 (100)
Small	3 (11)	24 (89)	27 (100)
Semi Medium	2 (18)	9 (82)	11 (100)
Medium	0 (0)	3 (100)	3 (100)
Overall	**9 (13)**	**61 (87)**	**70 (100)**

Figures in the parentheses show percentages to the total.

Table 7 shows quantity of produce sold by different categories through above marketing channels. The table shows that out of total marketable surplus in overall category maximum produce i.e. 59.03 per cent was disposed off through channel B i.e. Producer → Primary wholesaler → Secondary wholesaler → retailer → consumer followed by channel C, channel A and Channel D i.e. 17.83, 16.48 and 6.36 per cent. Similar results have also been observed by Chand *et al.* (2017).

Table 7: Farm category wise average produce sold through different channels (Quintals)

Farm size	Marketing Channels				
	A	B	C	D	Total
Marginal	24.01	51.92	14.19	4.66	94.78
	(25.33)	(54.78)	(14.97)	(4.92)	(100.00)
Small	49.44	124.95	33.7	13.31	221.39
	(22.33)	(56.44)	(15.22)	(6.01)	(100.00)
Semi Medium	62.7	307.17	102.29	31.48	503.64
	(12.45)	(60.99)	(20.31)	(6.25)	(100.00)
Medium	53.87	665.73	218.86	89.54	1028
	(5.24)	(64.76)	(21.29)	(8.71)	(100.00)
Overall	41.29	145.24	43.88	15.65	246.06
	(16.78)	(59.03)	(17.83)	(6.36)	(100.00)

Figures in the parentheses show percentages to the total.

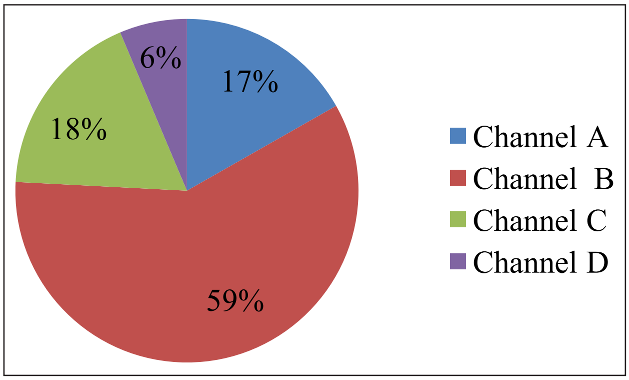

Fig. 1: Per cent share in total quantity transacted through different marketing channels

Marketing cost and price spread

Marketing cost incurred by various marketing functionaries has been shown in table 8.

Cost incurred by producers

In Channel A, producer sold their produce to the consumer through wholesaler. The total marketing cost incurred by the producer was worked out to be ₹ 254.6 per box. The major item of cost was found to be cost incurred on transportation which amounted to ₹ 90 per box. In Channel B, producer sold their

Table 8: Marketing costs and margins of different functionaries in the different marketing channels of Apple (₹/Box)

Particulars	Marketing Channels			
	A	**B**	**C**	**D**
(I) Marketing costs incurred by producer				
Net price received by farmer	1145.4	1012.4	950	887.4
Marketing cost	254.6	187.6		112.6
Farmer's selling price	1400	1200		1000
(II) Marketing costs incurred by pre harvest contractor				
Gross Price paid by pre harvest contractor			950	
Marketing cost			187.6	
Pre harvest contractor Margin			112.4	
Pre harvest contractor Selling Price/ Primary Wholesaler purchase price			1250	
(III) Marketing cost incurred by Primary Wholesalers				
Gross Price paid by Primary Wholesaler	1400	1200	1250	
Marketing cost	33	29	29	
Primary Wholesaler Margin	217	171	171	
Primary Wholesaler Selling Price/Secondary Wholesaler's Purchase Price	1650	1400	1450	
(IV) Marketing costs incurred by Secondary Wholesaler				
Gross Price paid by Secondary Wholesaler		1400	1450	
Marketing cost		128	129	
Secondary Wholesaler Margin		72	71	
Sec. Wholesaler Selling Price		1600	1650	
(V) Marketing costs incurred by Retailer				
Gross Price paid by Retailer	1650	1600	1650	1000
Marketing cost	20	20	20	20
Retailer Margin	230	180	230	180
Retailer Selling Price	1900	1800	1900	1200
(VI) Consumer purchase price	1900	1800	1900	1200

produce to primary wholesaler. The total marketing cost incurred by the producer was worked out to be ₹ 187.6 per box. In Channels C, producer sold their produce to pre harvest contractor so there was no marketing cost to be borne by the farmers. In Channel-D, producer sold the produce to the consumer through retailer. The total marketing cost incurred by the producer was worked out to be ₹ 112.6 per box.

Cost incurred by pre harvest contractor

The pre harvest contractor was found in the marketing Channels C. In Channel C pre harvest contractor spent ₹ 187.6 in the marketing, out of which major item of cost was packing material which accounted for ₹ 75 per box followed by commission charges of commission agent which was found to be ₹ 50 per box.

Marketing cost incurred by Primary wholesaler

The Primary wholesaler was found in the marketing Channel A, B and C. The total marketing cost incurred by the primary wholesaler was found to be ₹ 33 per box in channel A and ₹ 29 per box in channel B and C. The primary wholesaler marketing margins was found to be ₹ 217 in channel A and ₹ 171 per box in channels B and C.

Marketing cost incurred by Secondary wholesaler

The secondary wholesaler was found in the marketing Channel B and C. The total marketing cost incurred by the secondary wholesaler was found to be ₹ 128 per box in channel B and ₹ 129 per box in Channel C. The secondary wholesaler marketing margins was found to be ₹ 72 and ₹ 71 per box in both the channels.

Marketing cost incurred by retailer

Retailer was found to be present in all marketing Channel. The total marketing cost incurred by the

Table 9: Price spread and marketing efficiency of apple among the different marketing channels (₹/Box)

Particulars	Channel A	Channel B	Channel C	Channel D
Collector's or Producer price (₹)	1145.4	1012.4	950	887.4
Consumer's Price (₹)	1900	1800	1900	1200
Price spread	754.6	787.6	950	312.6
Producer's share in consumer rupee	60.28	56.24	50.00	73.95
Marketing cost	307.6	364.6	365.6	132.6
Marketing efficiency	1.52	1.29	1.00	2.84

Table 10: Farm category wise problems encountered by the apple growers

Sl. No	Particular/s	Marginal	Small	Semi Medium	Medium	Overall	Rank
1	Availability of skilled labour	79.31	66.67	72.73	66.67	72.86	II
2	Availability of packing material	44.83	55.56	45.45	33.33	48.57	VI
3	Lack of good infrastructure facility (Roads etc.)	75.86	74.07	81.82	66.67	75.71	I
4	Lack of transportation facility	68.97	66.67	72.73	33.33	67.14	IV
5	Malpractices by commission agents	17.24	25.93	27.27	33.33	22.86	VII
6	Lack of Marketing intelligence	65.52	74.07	72.73	66.67	70.00	III
7	Lack of availability of store houses (Cold stores)	55.17	62.96	72.73	100.00	62.86	V
	Chi Square value	52.04*					

*$p<0.05$.

retailer was ₹ 20 in all marketing channel. Retailer's margin was found to be ₹ 230 per box in channel A and C and ₹ 180 per box in channel B and D respectively.

Price spread and marketing efficiency among different marketing channels

The price spread and marketing efficiency of apple among different channels has been presented in Table 9. The price spread was found to be maximum in channel C ₹ 950 followed by Channel B, A, and D i.e. ₹ 787.6, ₹ 754.6 and ₹ 312.6 respectively. Producer's share in consumer rupee was found to be maximum in channel D i.e. 73.95 per cent and minimum in channel C i.e. 50.00 per cent. Marketing efficiency which has been an indicator of overall performance of the marketing channels was found to be highest in channel D followed by channels A, B, and C respectively. Though channel D has been found to be most efficient but the volume transacted was very less (6.36%).

Marketing related problems faced by the sampled households in the study area

Lack of transportation facilities, availability of skilled labour, lack of marketing intelligence, lack of good infrastructure, malpractices on part of commission agent are some marketing related problems faced by the orchardist. Amongst these problems the major problems was found to be related with good infrastructure like roads (Rank I) followed by availability of skilled labor (Rank II) and lack of marketing intelligence (Rank III). About 67.14 per cent of the farmers highlighted that they were not able to transport their produce because lack of transport facilities in the area. These marketing problems were followed by lack of store houses, lack of packing material and malpractices on part of commission agent. Similar problems has been faced by apple growers of Shimla district (Kudamala *et al*. 2019)

In order to test whether marginal, small, semi medium and medium orchardist differ significantly or not for the problems faced by them, the approximate chi square was used. Calculated chi square value was found to be 52.40 which has been found to be higher than tabulated value i.e., 19.67 at 0.05% probability level at 11 degree's of freedom. This indicates that all the problems differ significantly between categories of various farm groups.

CONCLUSIONS

Apple production has proved to be highly remunerative farm activity. The present study, by focusing on marketing aspect of apple produce projects the economic potential of apple cultivation in Kullu district. The produce was found to be marketed through four channels and maximum i.e about 59 percent has been disposed off through second channel i.e. producer – primary wholesaler-secondary wholesaler- retailer- consumer. Comparison between different channels revealed the highest share in consumer rupee has been found in Channel D (Producer – retailer-consumer) i.e. 73.95 per cent, followed by channel A (Producer–wholesaler–retailer–consumer) i.e. 60.28%, Channel B (Producer–Primary wholesaler–Secondary wholesaler-retailer–consumer) i.e. 56.24 % and C (Producer–Pre harvest contractor– Primary wholesaler–Secondary wholesaler – retailer–consumer) i.e. 50.00 %. Marketing efficiency has also found to be highest in channel D i.e. 2.84 which means smaller the channel more profitable it is. Apple being a perishable product incurs huge post- harvest losses. In order to minimize these losses, steps are required for quick disposal of the produce using improved techniques of refrigeration, proper storage and improved packing material, maintenance and expansion of network of link roads must get added attention. Non- availability of sufficient market information to apple growers also affects the operational efficiency of the apple markets as a consequence of which the growers miss the opportunities to sell their produce at remunerative prices, in right place and time. In this regard, credit and crop insurance of apple cultivation should be provided through the formal institutional sources so as to lessen the grower's dependence on traders and improve bargaining power in the market. The practice of e-marketing could be used to increase the marketing efficiency in apple trade.

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Impact of Cooperative Milk Collection Camp on Socio-economic Conditions of Dairy Farmers in Hooghly District of West Bengal

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ABSTRACT

The study examined the impact of cooperative milk collection camp on socio-economic conditions of farmers in Hooghly district of West Bengal. The farmers cooperatively collect milk in the collection camp namely Bholanath Dairy and milk was sent to Arambagh chilling plant. The primary data were collected from 60 cooperative farmers and 10 agricultural farmers through purposive random sampling method. The present collection camp covers 7 villages with 402 milk farmers and total milk collected in last 6 months was 216000 litres. The average herd size per family was 1.28 for local cow and 0.92 for crossbreed cow. The major component of variable costs incurred were feed which includes green fodder, dry fodder concentrates and grains. The total variable cost incurred by dairy farmer per animal per year was ₹ 26552.44. The total cost of producing milk per animal per year was ₹ 30149.99. The gross return obtained per animal per year was ₹ 51450.00. Lack of technical facility, high cost of cattle feed, improper grading; measurement & timings of milk collection in the camp were the major problems of the dairy farmers. The study farther showed that the families which were attached with dairy activities side by side of agriculture generated more income than solo agricultural families. It also found that the number of dairy farmers decreased in the cooperative milk collection camp with the increase of distance. So, this model might be replicated in every villages. There was also a scope for reduction in cost of milk production by using modern methods and technologies of dairy farming that was completely absent in the study area.

Highlights

- The main problems faced by the dairy farmers is the lack of revenue due to unorganised supply chain management in many parts of rural West Bengal. The present study focuses to find out the impact of cooperative dairy farming on the income of dairy farmers.

Keywords: Cooperative milk collection camp, dairy farmers, agricultural farmers, green and dry fodder, concentrate

Agriculture is the single most activity, which is not only the reliable source of food throughout the world (Mukherjee and Vasudev, 2014) but also provides largest employment in many third world countries (Shuya and Sharma, 2014; Gadad, 2015). About 61.5% of the 1300 million Indian population is rural and dependent on agriculture (Agricultural Cencus, 2011). The continuous and intensive agriculture practices for meeting the objective of food security, leads to over exploitation of the natural resources. In this situation the dairy as allied sector of agriculture plays a very important productive role in Indian economy because the contribution of milk is huge in GNP as a second largest agricultural product, only after rice. Besides, crop husbandry practices that completely based on land can only provide seasonal

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income to the farmers whereas dairy provides not only off seasonal employment but also generate regular flow of income throughout the year to the farmer (Sarker and Ghosh, 2008).

In recent period, per capita consumption of food grain has become stagnant or on decline, but in the cases of livestock product it has significantly increased (Kumar *et al.* 2011). In the early stages of economic development, agro-based industries occupied a prominent position in the industrial sector (Yasmeen *et al.* 2016). Dairy farming in India has grown hugely from being a traditional family run occupation to an organized industry with technological specializations (Simranjit *et al*. 2017). Dairy cooperatives are the integral part of the dairy development and milk marketing in India that was started through "operation flood" in 1970 (Gadad, 2015). Milk cooperative is the key element for overall development of rural economy. Though it was started 70's era, but it was not effective throughout the country (Singh and Pundir, 2000). The rural economic situation of states like Gujarat, Tamil Nadu, Maharastra and Karnataka has developed through development of cooperative dairy (Benni, 2005). These states have taken AMUL type cooperative structure that is (i) In state level, the State Milk Marketing Federation (ii) in district level, the District Milk Producer Co-operatives Union and (iii) in Village level, Primary Milk Producer's Co-operative Society. In West Bengal, this structure was also present from 1983 through West Bengal Cooperative Milk Producers Federation Limited (WBCMPFL). But private or non-cooperative dairy is prominent in West Bengal (Sarker and Ghosh, 2008).

In this perspective, the study of a new cooperative milk collection camp that had started in a farming community in state like West Bengal is very relevant. Though the camp does not fully work as a Primary Milk Producer's Co-operative Society, it has potentiality to develop. The study would throw light on the extent of coverage under cooperative milk collection camp, the economic difference of dairy farmers and agriculture farmers, and problem associated with dairy activities that would enable the academicians and policy makers to formulate and implement appropriate policies for a balanced and integrated agricultural development.

METHODOLOGY

The study area and the cooperative milk collection camp was purposively selected as there was no milk cooperative in the region and as the cooperative had newly started. The study is predominantly based on primary data that were collected by using pretested schedule through field survey. 60 cooperative dairy farmers and 10 agricultural farmers were randomly selected for getting primary data and the secondary information were also collected from the Secretary of the Cooperative Society for the study. The collected data were coded, classified so that the findings become meaningful. Besides, tabular analysis was also done of the coded and classified data that involved the computation of means, percentages. Budgeting technique was used for working out the costs-returns of the milk production. Garrett ranking technique was also used for evaluating the problems faced by the farmers.

RESULTS AND DISCUSSION

The secondary data revealed that the milk collection cooperative namely Bholanath Dairy was started on 25th August, 2017 at Haruah village of Pursurah Block, Hooghly. It was started with 200 farmers for saving them from the exploitation by the traditional traders and middlemen. The timings of milk collection were 7 am to 10 am and 6 pm to 8:30 pm. The collected milk was sent to the Arambag chilling plant and then those were sent to different processing units. In recent period the camp covers 7 villages with 402 milk farmers and total milk collected in last 6 months was 216000 litres. The distribution of milk producing farmers in different villages are presented in table 1. It can be noticed that most of the milk producing farmers under the collection camp were from Chiladangi (47.76%) and Haruah (23.38%) villages and in the case of Gholdigrui (06.71), Balarampur (08.45%), Gopimohanpur (9.95%) the number of farmers were low, where it was very low in Hati (1.74%) and Sundurush (3.23%). It was mainly due to the fact that Chiladangi and Haruah are adjoining villages of the collection camp, in the case of Gholdigrui, Balarampur and Gopimohanpur, they are slightly away (about 1.5 km) from the village. But Hati and Sundurush are far away (about 2.5) from the village so the numbers of milk producing farmers were very low in the camp-cooperative.

Table 1: List of Villages and number of dairy farmers under the cooperative milk collection camp

Sl. No.	Village name	No. of dairy farmers	Percentage
1	Haruah	94	23.38
2	Gopimohanpur	40	9.95
3	Chiladangi	192	47.76
4.	Gholdigrui	27	06.71
5	Balarampur	34	08.45
6	Hati	7	01.74
7	Sundurush	13	03.23
	Total	**402**	**100**

Composition of the Dairy Animals of Sample Farmers

In the study area, there were dairy animals except buffaloes. Hence, dairy farming forms a major element as an additional source of income of the study area for the farmers. The details about the Composition of dairy animals of sample farmers and their value are presented in Table 2.

Table 2: Composition of dairy animals of sample farmers

Sl. No.	Type of animals	Total no. of animals	Average herd size per sample farmers	Average value of animals (present market value) ₹
1	**Local**			
(A)	Bulls	7	0.12	12000.00
(B)	Cows	77	1.28	11375.00
2	**Crossbreed**			
(A)	Bulls	0	0	NA
(B)	Cows	55	0.92	25866.00

Source: *Primary data and author's calculation.*

It is noticed from table 2 that the number of local bulls were 7 and the average value of these bulls was ₹ 12000.00, the local cows were 77 and their average value was ₹ 11375.00. The number of cross breed cows were 55 and their total value was ₹ 1422630.

The number of local cows were more than crossbreed cows, it was mainly due to lack of knowledge about dairy farming of the sample farmers that they had a wrong perception about crossbreed cows that those cows feed more, easily susceptible to diseases and the milk was watery.

Pattern of Milk Marketing of the Dairy Farmers

The selling pattern of milk by the sample farmers to the collection camp were presented in the table 3. The average quantity of milk sold differed according to the stage of lactation period. In the initial period of lactation, they sold 4.12 litres in the morning and 3.60 litres in the evening. In the middle period of lactation, they sold 3.80 litres in the morning and 2.98 litres in the evening. Whereas in the end period of lactation the quantity of milk sold decreased. They sold 2.79 litres in the morning and 1.70 litres in the evening.

Table 3: Pattern of milk marketing by the dairy farmers

Sl. No.	Lactation period	Average quantity of milk marketed (kg/day)		
		Morning	Evening	Total
1	Initial period (1^{st} 3 lactation)	4.12	3.60	7.72
2	Middle period (3-5 lactation)	3.80	2.98	6.78
3	Terminal period (6 & above lactation)	2.79	1.70	4.49

Source: *Primary source and author's calculation.*

Costs and Returns Structure in Milk Production

The money spent for purchasing various inputs in milk production are presented in table 4. The different inputs of dairy farming are dry fodder, green fodder, grains, concentrates, veterinary medicines and labour charges etc.

Total variable cost was per animal per year was ₹ 30894.00 in dairy farming. The major items of variable costs were grains, concentrate, green fodder and dry fodder. The cost grains contributed the maximum cost i.e. ₹ 9600.00. The concentrates also contributed huge cost that was ₹ 7800.00. It is because concentrates are responsible for high milk productivity. The cost of dry fodder and the green fodder were ₹ 2250.00 and ₹ 3744.00 respectively. The main objective of any type of farming is to maximize the production. In case of dairy farming, it can be achieved by feeding the dairy animal with optimum rate.

Thus, the costs for feed contributes more than half

Table 4: Cost involved in milk production (per animal-per annum)

Sl. No.	Particulars	Unit	Quantity/year	Unit cost	Cost/year In P ₹
(A)	***Variable cost***				
1	Green Fodder	Kg	6240	₹ 60/qt	3744.00
2	Dry Fodder	Kg	2250	₹ 100/qt	2250.00
3	Concentrates	Kg	650	₹ 1200/qt	7800.00
4	Grains	Kg	1200	₹ 800/qt	9600.00
5	Labour	Man-Days	30 MDs	₹ 200/MD	6000.00
6	Veterinary & medicine	₹			1000.00
7	Miscellaneous cost	₹			500.00
(A)	***Total Variable cost***	₹			30894.00
(B)	***Fixed cost***				
1	Depreciation on buildings	₹			1740.00
2	Depreciation on animals	₹			1530.50
3	Interest on Fixed cost (10%)	₹			327.05
(A)	***Total Fixed cost***	₹			3597.55
(B)	***Total cost (A+B)***	₹			34491.55

Source: *Primary data and author's calculation.*

of the costs of dairy farming. The fixed cost of dairy farm is depreciation on building and animals. The cost of depreciation on building and animals were ₹ 1740.00 and ₹ 1530.00, respectively. The interest on the fixed capital was ₹ 3597.55. The total fixed cost and total cost for dairy farming were ₹ 3597.55 and ₹ 34491.55. The returns from dairy farming are come by selling of milk, dung (used as fuel and for preparing manure) and calves. The details regarding the returns from the dairy farming are presented in Table 5.

Table 5: Returns from milk production (per animal-per annum)

Sl. No.	Particulars	Unit	Quantity/ year	Unit Costs	Returns/ year ₹
1	Sale of milk	Kg	1710	₹ 25/kg	42750.00
2	Sale of dung	Tons	2	₹ 600/ton	1200.00
3	Sale of calves	Numbers	1		7500.00
	Gross returns	₹			51450.00
	Net returns	₹			16958.45

Source: *Primary data and author's calculation.*

In the return section of the dairy farming, the maximum returns come from sale of milk which was ₹ 42750.00. The contribution of sale of calves and sale of manure in returns were ₹ 7500.00 and ₹ 1200.00 respectively. The gross return obtained from per animal per year was ₹ 51450.00. The net return was ₹ 16958.45 per animal per year. So, it could be said that from the dairy farming, the farmers can achieve a huge amount of profit side by side of agriculture that helps for improving their economic condition.

Income Difference of Different Activities in The Study Area

The income difference of different activities of the study area are presented in the table 6. Separately the income data of 10 farmers who completely depend on agriculture were collected for making comparison with other activities.

Table 6: Income difference of different activities (per annum)

Sl. No.	Activities	Income (₹) /annum
1	Agriculture	110000.00
2	Agriculture + dairy	131300.01
3	Others + Dairy	172000.00

Source: *Primary data and author's calculation.*

Average income of the agriculture families in the study area was ₹ 110000.00 per annum where agriculture + dairy and dairy + others (shopkeeper/business/teacher etc.) were ₹ 131300.00 and ₹ 172000.00 respectively. So, it can be said that dairy provides an additional earnings side by side their main occupation.

Problems Faced by the Farmers in Economically and Marketing of Milk

The problems faced by the milk producing farmers were ranked by using Garett ranking method and are presented in Table 7 and 8.

Table 7: Economic constraints faced by dairy farmers

Sl. No.	Constraints	Garrett total score	Garret mean score	Rank
1	Lack of technical facility	3224	53.73	2nd
2.	High cost of crossbreed cow	2507	41.78	4th
3	High cost of cattle feed	3239	53.98	1st
4	High cost of veterinary service	3176	52.93	3rd

Source: *Primary data and author's calculation.*

Table 8: Marketing constraints faced by dairy farmers

Sl. No.	Constraints	Garrett total score	Garret mean score	Rank
1	Low price of milk	3240	54	1st
2	Delay in getting price	2719	45.31	4th
3	Timing of milk collection & measurement of milk	2954	49.23	3rd
4	Improper grading of milk	3087	51.45	2nd

Source: *Primary data and author's calculation.*

In the study area the high cost of cattle feeds was the major problem which ranked I with a mean score of 53.98. Lack of technical facility was ranked II with a mean score of 53.73. High cost of veterinary service ranked III with a mean score of 52.93 and high cost of crossbreed cow was ranked IV with a mean score 41.78. The sample farmers expressed High cost of cattle feeds as the major problem in milk production. The farmers produced compounded feeds by mixing other low quality feeds like paddy husk, paddy straw, wheat straw, wheat bran, etc. with concentrate so that the cost feed might be reduced. The modern technology of dairy farming was not applied in the area. The farmers did not use any machines like milking machine, fodder cutting machine. It was mainly due to lack of knowledge and awareness about dairy farming. Majority of the farmers (52.93 mean score) also expressed their dissatisfaction over the Non-availability of emergency veterinary services and artificial insemination facilities. This may be mainly because of limited veterinary doctors in the study area. High cost of cross-breed cattle was also one of the problem in milk production. So, the animal husbandry department need to undertake the cattle breeding work on larger scale to supply good milch breeds to the dairy farmers.

Farmers said that the price fixed for milk that cannot generate enough profit. Low price of milk was ranked I with a mean score of 54. Farmers also expressed their dissatisfaction over the grading of milk. Improper grading was ranked II with a mean score of 51.45. Farmers experienced that there was partiality in timing of milk collection &malpractices in measurement of milk. This problem was ranked III with a mean score of 49.23. Farmers opined the difficulty in getting the payment in time. This problem was ranked IV with a mean score of 45.31.

Farmers opined that the price of milk cannot generate enough profit. This may be because of increasing cost of inputs required for milk production. Farmers also expressed their dissatisfaction over the grading of milk. This may be mainly because the camp did not give much importance to the grading of the commodity. Farmers opined that there was prevalence of malpractices in timing of milk collection & measurement of milk. They said that in this cases partiality was occurred. It might be have wrong perception of people. Farmers experienced the difficulty in getting the payment for their produce in time. The amount was paid through their bank account. The delay occurred because there may be chance of bank related problem.

CONCLUSION

The findings showed that the number of dairy farmers decreases in the cooperative milk collection camp with the increase of distance from the camp. So, this model can be started in every village. The non-dairy farmers should be encouraged to start the dairy activities for increasing their income level. In this case the members of the camp may be act as a role model for motivating the non-dairy farmers. Besides following suggestions canbe taken for better performing of the camp.

1. There buffalos were not reared, farmer should be influenced to start buffalo farming

2. There is a scope for reduction in cost of milk production by using modern methods and technologies (quality feed and different equipment) of dairy farming that is completely absent in the study area.
3. The production efficiency of dairy animals may be increased with selection of cross breed animal due to better milk production as compared to other local breeds.
4. The government should focus on increasing emergency veterinary services and artificial insemination facilities in the region.
5. Conduct of animal fairs, milking competitions for encouraging the dairy farmers that may boost the milk production. Besides it may cause a 'war' like situation among the milk producers and may encourage non-dairy farmers to involve in dairy activity.

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Scenario of Major Pulse Production in Tamil Nadu: A Growth Decomposition Approach

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ABSTRACT

In the present study, an attempt has been made to analyze the trend in the production of the total pulses crop in Tamil Nadu for the period 1965-66 to 2016-17, i.e. past six decades in the state. The gross area under total pulses in Tamil Nadu was in the range of 3.97 to 7.85 lakh ha per year over these six decades. The average production of total pulses was in the range of 1.01 lakh tonnes to 3.37 lakh tonnes per annum. However, the yield of total pulses was increased over the year. The yield of total pulses was 256 kg/ha during 1960's which increase to above 430 kg/ha during 2016-17. The compound growth rate of yield over six decades was positive and significant in area and production except the period II are negative signs. Area under Black gram, Green gram, Red gram, Bengal gram and total pulses registered positive growth during 1965-66 to 1985-86. Increase production of Black gram, Green gram, Bengal gram and total pulses were contributed by their yields, whereas area and its interaction with yield have adversely affected the production. Decline in production of Horse gram was due to area effect and interaction effect. The decomposition analysis shows that increase in production of pulses during the period 2006-2016 was driven mainly by yield improvements. Since the supply of resources, especially land is limited in nature; productivity of pulses should be boosted up by the adoption of improved technologies like hybrid pulses cultivation and various techniques of production to meet the future increased demand.

Highlights

- To meet growing demand and to reduce the import of pulses, more such initiatives are needed, so that the country can attain self- sufficiency. Policy support should be promoted which will help to increase per capita availability of pulses, reducing import dependence and to some extent it will stabilize the pulse prices. This research will be helpful for policy makers to take decisions regarding performance of pulses in Tamil Nadu.

Keywords: Pulses, growth, area decomposition, Yield effect, interaction effect

Pulses is a major source of protein for a huge section of state particularly vegetarian population. India, with a share of 22 per cent, is the largest producer of pulses in the world. But the production of pulses has not been able to keep pace with their domestic demand, resulting in imports of 2-3 million tonnes of pulses per annum. For the two decades, post-1991, pulses production is almost stagnated at around 14 million tonnes, leading to a significant decline in their per-capita availability, from 61g/day in 1951 to 54.5 g/day in 2018 one-third less than the recommended intake of 65 g/day (ICMR, 2018). Further, the mismatch between demand and supply has made the pulses market more volatile. Closing the gap between demand and supply of pulses would require production to grow at least by 4 per cent per annum (Kumar, 1998; IIPR, 2011). During recent years people are recognizing the nutrient

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superiority and health benefits of pulses compared to other grains. There may be an increase in demand for pulses due to recent inclusion of pulses in food security bill coupled with increased awareness of people about inclusion of pulses in daily meals for healthy living and also pulses are ideal solution for climate change. So, there is a need to increase the pulse production with the increasing demand and to recognize them as climate change complaint crops to promote their cultivation and consumption which makes them state food and farming future. With this backdrop, the paper has examined to study the growth pattern of area, production, and yield of major pulses in the Tamil Nadu.

MATERIALS AND METHODS

The study uses secondary data pertaining to area, production and yield of pulses in India during the last six decades i.e. from 1965-66 to 2017-18 collected primarily from *Agricultural Statistics at a Glance*, Season and crop Report, Directorate of Economics and Statistics, Ministry of Agriculture, Tamil Nadu. The data was analyzed through percentages and averages to examine the change in area, production and yield of major pulse crops viz., Black gram, Green gram, Red gram, Bengal gram, Horse gram and total pulses.

(i) Measurement of growth rate

In the present study, Compound growth rates were calculated by exponentially fitting the time series data of area, production and yield of pulses and major pulse crops were calculated for three time periods *viz.*, period-I (1965-66 to 1985-86), period-II (1986-87 to 2005-06), Period III (2006-07 to 2017-18) and overall period (1965-66 to 2017- 18) at the state level against time using the following formula:

$$Y_t = a\, b^t\, U_t \qquad \ldots(1)$$

Where,

Y_t = Dependent variable for which growth rate was estimate in year t

a = Intercept

b = Regression coefficient

t = Year which takes values 1, 2, …, n.

U_t = Disturbance term in year t.

The equation (1) will be transformed into log-linear and written as:

$$\log Y_t = \log a + t \log b + \log U_t \qquad \ldots(2)$$

Equation (2) will be estimated by using Ordinary Least Square (OLS) technique.

The compound growth rate (g) will be then estimated by the identity given in equation (3),

$$g = (b - 1) \times 100 \qquad \ldots(3)$$

Where,

g = Estimated compound growth rate per annum in percentage.

b = Antilog of regression coefficient value.

(ii) Decomposition of growth components

Decomposition analysis was used to measure the relative contribution of area and yield towards the total production changes of major pulses.

This method is explained below:

$$P_0 = A_0 \times Y_0, \text{ and}$$

$$P_t = A_t \times Y_t \qquad \ldots(1)$$

Where, A_0 and A_t represent the area and Y_0 and Y_t represent the yield in the base year and n^{th} year, respectively.

$$P_t - P_0 = \Delta P,$$
$$A_t - A_0 = \Delta A$$
$$Y_t - Y_0 = \Delta Y \qquad \ldots(2)$$

Upon simplification of equation (1) and (2), it could be written as:

$$P_0 + \Delta P = (A_0 + \Delta A)\,(Y_0 + \Delta Y)$$

Hence,

$$P = \frac{A_0 \Delta Y}{\Delta P} \times 100 + \frac{Y_0 \Delta A}{\Delta P} \times 100 + \frac{\Delta Y \Delta A}{\Delta P} \times 100$$

Production = Yield effect + Area effect + Interaction effect

Thus, the total change in production can be decomposed into three components viz., yield effect, area effect and the interaction effect due to change in yield and area.

RESULTS AND DISCUSSION

Status of Pulses Production in Tamil Nadu

In 2017-18, Tamil Nadu produced 5.56 lakh tonne of pulses from an area of 8.24 lakh ha (Table 1). Over time, there has been an increase in pulses production mainly due to improvement in their yields; the average yield increased from 256 kg/ha in 1965-66 to 675 kg/ha in 2017-18. Table 1 provides the disaggregated information on pulses by growing period, i.e. *kharif* (June-September) and *rabi* (October-Dec). The *rabi* pulses account for half of the total pulses area and contribute close to two-thirds to the total production, and these proportions have not changed much over time, indicating no significant seasonal shift in pulses production. However, a faster increase has been observed in the average yield of *rabi*-pulses in the recent decade; it increased at an annual rate of 7.18 per cent during 2006-2016 as compared to 2.57 per cent in the previous decade of 1965-1985. The production of pulses, however, is concentrated in a few Districts in Tamil Nadu. The districts of Villupuram, Salem, Cuddalore, Thiruvarur, Vellore, Thiruvannamalai and Thanjavur account for more than 60 per cent of the total area as well as production of pulses (Table 2).

Table 1: Average Area of major Pulses in Tamil Nadu 1965-66 to 2017- 18

Crop	**Average Area ('000 ha)**			
	Triennium Ending 1965-66	**Triennium Ending 2017-18**	**Net Change**	**Percent Change**
Black gram	44.33	417.10	372.78	840.99
Green gram	42.78	195.13	152.36	356.14
Red gram	52.04	54.93	2.90	5.56
Hose Gram	200.79	58.91	-141.89	-70.66
Bengal gram	2.12	5.10	2.98	140.30
Total Pulses	397.79	832.24	434.45	109.22

Villupuram has a higher share in the *rabi*-pulses. It alone accounts for one-third of the total production. On the other hand, Thanjavur and Thiruvarur have higher shares in *kharif*-pulses; together they contribute 17 per cent to the total production of *kharif* - pulses. Further probe shows that though pulses have a wider regional spread, there are niches for different pulses. Black gram production is concentrated in Villupuram (29 %), and Cuddalore (14 %); Green gram is concentrated in Thanjavur (23 %) and Salem (22%); Red gram is concentrated in Vellore (33%) and Horse gram is concentrated in Krishnagiri (23 %), and Bengal gram is strenuous more in Tiruppur (50%). This indicates the need for crop - and region specific strategies for enhancing pulses production in Tamil Nadu.

Change in area, production and yield

The analysis of average area, production and yield indicated an increase in area and the increase in yield under all the pulse crops except Horse gram from TE ending 1965-66 to TE ending 2017-18 (Table 1). The total area under pulses increased from 397.79 thousand ha to 832.24 thousand ha (109.22 %) and the decline in the area was highest in the case of Horse gram (70.66 %) which contributes more to the reduction in the area under total pulses. The production of almost all the pulse crops increased over the study period due to the increase in yield despite of reduction in area under the crop, except in the case of Horse grams.

Table 2: Average Production of major Pulses in Tamil Nadu 1965-66 to 2017- 18

Crop	**Average Production ('000 tonnes)**			
	Triennium Ending 1965-66	**Triennium Ending 2017-18**	**Net Change**	**Percent Change**
Black gram	14.10	283.97	269.87	1913.95
Green gram	10.28	89.53	79.25	770.89
Red gram	23.63	50.28	26.65	112.76
Hose Gram	42.46	35.17	-7.29	-17.17
Bengal gram	1.09	3.80	2.71	248.35
Total Pulses	101.96	522.68	420.72	412.63

Although, the yield of Horse grams is increased by 161.61 %, the decline in area under these crops 70.66 %. Shrinkage of area under Horse grams in Tamil Nadu is due to crop diversification towards commercial crops. With decline in area, impressive growth in production of total pulses was mainly contributed by growth in yield (Kannan and Sundaram, 2011). Green gram and Bengal gram recorded 770.89% and 248.35% increase in production with an increased yield of 85% and 44.36 % respectively over the study period. Black gram production was increased vastly by 1913.95 %, which is largely attributed to the highest increase in yield 114.15 per cent among the pulse crops under study.

Table 3: Average Yield of major Pulses in Tamil Nadu 1965-66 to 2017- 18

Crop	Average Yield (kg/ ha)			
	Triennium Ending 1965-66	Triennium Ending 2017-18	Net Change	Percent Change
Black gram	318	681	363	114.15
Green gram	240	444	204	85.00
Red gram	451	921	470	104.21
Hose Gram	211	552	341	161.61
Bengal gram	514	742	228	44.36
Total Pulses	256	626	370	144.53

Growth performance of area, production and yield

Annual compound growth rates were calculated for the pulse crops during 1965-66 to 1985-86 (period-I), 1986-87 to 2005-06 (period-II), 2006-07 to 2016-17 (period III) and 1965-66 to 2017-18 (overall period) and the results are presented in Table 4. Black gram registered significant increase in area, production and yield during period-I (1965-66 to 1985-86) with an annual compound growth rate (CAGR) of 8.28 %, 9.14 % and 0.80 % respectively. Production of black gram reduced significantly (1.96 %) during period-II even though there is a significant increase in yield (0.94 %) due to high and significant positive growth in area (2.03 %), and also recorded significant increase in production with a growth rate of 14.16 % per annum during the period III (2006-07 to 2016-17). The major reasons for productivity improvement were use of high yielding varieties and increased utilization of input for pulse cultivation (Hile *et al*. 2013).

With the exception of Horse gram, the area and production of most of the pulse crops in Tamil Nadu showed positive growth rate in the time period

Table 4. Compound Growth Rate for Major Pulses in Tamil Nadu (1965-2016)

	Period I (1965-1985)	Period II (1986-2005)	Period III (2006-2016)	Overall Period (1965-2016)
Black gram				
Area	8.28* (7.761)	2.03^{NS} (1.002)	4.69** (2.854)	3.05* (7.536)
Production	9.14* (7.037)	-1.96** (-2.436)	14.16* (3.603)	4.42* (10.529)
Yield	0.80 (1.364)	-0.94** (-2.015)	5.15 (1.543)	1.30* (6.445)
Green gram				
Area	3.00* (3.024)	4.05** (2.850)	4.21** (2.354)	2.19* (7.108)
Production	5.97* (3.630)	1.61*** (1.821)	9.20^{NS} (1.685)	3.38* (8.693)
Yield	1.77** (2.528)	-0.22^{NS} (-0.491)	2.11^{NS} (0.459)	1.22* (5.153)
Red gram				
Area	2.25* (2.99)	-5.21* (-8.150)	10.22* (6.051)	-1.06** (-3.177)
Production	2.25* (5.541)	-5.68* (-7.140)	14.04* (4.105)	0.02^{NS} (0.053)
Yield	2.25* (5.360)	-0.50^{NS} (-0.741)	2.71^{NS} (0.760)	0.84* (4.177)
Bengal gram				
Area	7.32* (4.478)	-0.81^{NS} (-0.944)	-1.49^{NS} (-0.886)	0.67** (1.754)
Production	8.35* (5.384)	-0.90^{NS} (-0.967)	-1.62^{NS} (-0.962)	1.10* (2.760)
Yield	0.92** (2.333)	0.22^{NS} (1.074)	0.01^{NS} (0.037)	0.44* (5.625)
Horse gram				
Area	-2.16* (-6.529)	-3.51* (-6.045)	3.41^{NS} (1.234)	-3.13* (-17.695)
Production	1.11^{NS} (1.211)	-4.35* (-3.705)	3.43^{NS} (0.689)	-1.26* (-3.650)
Yield	3.11* (3.959)	-1.22*** (-1.855)	-1.18^{NS} (-0.489)	2.01* (8.755)
Total Pulses				
Area	2.82^{NS} (1.596)	-1.37* (-3.258)	5.16* (3.823)	1.07* (3.377)
Production	4.21* (6.283)	-2.30* (-3.687)	12.71* (3.371)	2.00* (6.673)
Yield	2.57* (7.624)	-0.94** (-2.865)	7.18** (2.644)	1.31* (7.462)

Note: ** Significant at 1% level of significance, ** Significant at 5% level of significance,*
**** Significant at 10% level of significance NS - Non Significiant*
Source: *Computed from DES, Tamil Nadu*

I (1965-1985). Even though the area shows the negative growth, the production and productivity was positive and significant for all the crops except for Horse gram. This may be because of the introduction of new varieties, technologies and scheme (NFSM) and a few hybrids in select pulse crops such as Black gram, Green gram and Red gram.

The area and production of most of the pulse crops in Tamil Nadu showed positive growth rate in the time period III (2006-07 to 2017-18). Even though the area and production shows the positive growth, the productivity was positive and significant for all the crops except for bengal gram. Even though there is an increase in yield with the use of improved/ hybrid seeds, there is not much increase in production as farmers shift to other, more remunerative crops (Basavaraj and Rao, 2012). Significant positive growth in production (2.76 % CAGR) was observed in Bengal gram during overall period due to relatively higher increase in yield (5.62% CAGR) and less decline in area (0.91 % and 0.18 % CAGR).

Area under red gram increased significantly during period-I with an annual growth rate of 2.25 % but reduced significantly during Period II and overall study period with negative growth rate of 5.21 and 1.06 per cent per annum. Although there was an increase in the yield of Red gram, higher decline in area resulted in reduction of total production by 7.14%, during the second periods. All the pulse crops registered significant decline in area during period II (1985-86 to 2005-06) which started during eighties, due to increase in cultivated area of major cereal crops, oilseeds and other cash crops. Production increased significantly in almost all the pulse crops during overall study period except in case of Horse gram. Area and production of small Horse gram registered negative growth and highly significant during overall periods because the increased growth in per hectare yield is less than reduction in area.

Decomposition of growth components

The total change in the production of pulse crops was decomposed in to three effects i.e. area effect, yield effect and interaction effect (Table 5). The percentage contribution of area, yield, and their interaction is increasing or decreasing the production of pulses for each decades from 1965-66 to 2016-17 and overall period. The relative contribution of area, yield and their interaction in increasing the total production of pulse was 17.05 %, 48.33 % and 34.66 % respectively in the overall period of the study area. Table 3 revealed that, in period I except horse gram, the contribution of area and yield effect were positive for major crops and it was more responsible for the production of black gram, green gram, red gram and horse gram. In case of horsegram, the area effect was positive and yield effect was negative which influenced on horsegram production. The interaction effect was positive in black gram, moong, red gram and horse gram whereas in red gram it was negative.

Table 5: Decomposition Analysis for Major pulses in Tamil Nadu

	Period I (1965-1985)	**Period II (1986-2005)**	**Period III (2006-2016)**	**Overall Period (1965-2016)**
Black gram				
Area Effect	29.27	113.61	-45.93	-5.91
Yield Effect	69.75	-2.64	57.48	56.96
Interaction Effect	0.87	-10.71	88.28	48.88
Green gram				
Area Effect	64.22	-145.35	474.95	-168.28
Yield Effect	25.06	139.46	-17.93	62.40
Interaction Effect	10.63	106.07	-357.23	205.91
Red gram				
Area Effect	66.96	48.59	-48.56	53.04
Yield Effect	23.82	51.68	114.30	-13.27
Interaction Effect	9.17	-0.21	34.32	60.20
Bengal gram				
Area Effect	18.96	27.84	-2.83	9.68
Yield Effect	102.14	146.53	119.32	78.46
Interaction Effect	-21.00	-74.63	-16.92	11.76
Horse gram				
Area Effect	214.45	45.62	144.20	-25.99
Yield Effect	-149.94	74.08	94.44	222.51
Interaction Effect	35.19	-19.69	-139.00	-96.83
Total Pulses				
Area Effect	70.74	55.84	-64.06	17.05
Yield Effect	49.09	58.92	71.19	48.33
Interaction Effect	-19.75	-14.76	92.87	34.66

In total pulses, area and yield effects were positive and area effect was very high accounting for 70.74 per cent. In period II except green gram the interaction effect in positive, all other effects were negative for all crops. Total pulses production was highly influenced by area and yield effect. The negative yield effect was found to be the highest in Horse gram (-149.94) for period I and it was positive and highest in period II (74.08 per cent). Interaction effect was found to be positive and highest in Horse gram (35.19 per cent) for period I and it was lowest in Total pulses (-19.75).

In the case of period III, the Black gram, Green gram and Horse gram the area effect is negative. The negative area effect was found to be the higher in total pulses, Red gram and Black gram with 64.06, 48.56 and 45.93 per cent respectively, but in overall period the area effect was the highest in Red gram (53.04 per cent). In overall period all the effects were positive in Bengal gram and total pulses, whereas yield effect and interaction effect was positive in urad and green gram. Among the major crops, interaction effect was high in green gram production and yield effect was high in horse gram during overall study period.

In case of total pulses, yield effects were positively higher and they were responsible for total pulses production. The increase in production of Horse gram, Bengal gram, Green gram and Black gram was mostly due to yield effect (222.51 %, 78.46 %, 62.40 % and 56.96 % respectively), where the area effect contributed negatively in green gram, horse gram and black gram during the overall study period. The reduction in Red gram production was due to yield effect by 13.27 %, whereas in the Bengal gram the contribution of both area and productivity effect has been highly positive during the overall period. The interaction effect is positive for all pulse crop except Horse gram, while area effect was greater than the yield effect Red gram. In case of interaction effect green gram was found to be higher (205.91 per cent).The results of the decomposition analysis clearly indicates that change in yield was mainly responsible for changes in production for most of the pulse crops. It indicates that yield was a major driving force behind the temporal changes in production of most of the pulse crops in the state over the study period from 1965-66 to 2016-17.

CONCLUSIONS AND POLICY IMPLICATION

The present study highlighted the fact that the area, production, and yield showed increasing trends in pulses production in the state. The growth of area, production, and yield for pulses registered positive during overall period (1965-66 to 2016-17). In recent years, Tamil Nadu from an area of 7.85 lakh ha has achieved pulses production to the tune of 3.37 lakh tonnes, which is a record because pulses production was never beyond 1-2 lakh tonnes during the period 1965-1985. The major pulses growing districts are Villupuram, Thootukudi, Thiruvarur, Salem, Cuddalore and Nagapattinmam. Though there has been an upward and significant boom in terms of area, production and yield of overall pulses in Tamil Nadu, it became sluggish. There exist a gap between domestic demand and supply of pulses, which obligates us to import pulses.

The growth rate of total pulses area, production and productivity first decline and then increased in the overall period. The results of decomposition analysis revealed that yield and interaction effects were positively contributed to the production of pulses. The yield effect has a greater contribution in each decades separately except in sixties for Horse gram also in eighties for Black gram and Green gram and response to change in production in these periods is due to change in acreage. In sixties and the decade of 2006's the change in production was due the change in area. The interaction of area and yield is not much except the decades of 2006's. Overall the production is changed mainly due to yield affect.

It could be concluded that there has been a noteworthy performance in yield aspect of total pulses at the state. It was mainly due to the positive impact of government interventions like increasing government thrust in technological advancement, rapid and intensive extension services, and institutional support through different intervening programs like National Food Security Mission (NFSM) and A3P (Accelerated Pulses Production Programme). It may be counseled that government has to intrude and enhance the productivity of pulses to offset the gap between production and consumption of pulses with the aid of adopting proper strategies, technological breakthroughs have to be implicated on the way to enhance the yield of total pulses on par with total food grains, socio-economic impact assessment studies, supply chain management research, value chain evaluation research ought to be conducted from agricultural economics perspective, pulse farming and appropriate measures must be adopted to aid in coordinated researches and care have to be taken on value addition which enhances the revenue from pulses. To further increase the area under pulse cultivation and yield of pulses, research and policy support should be promoted which will help to increase per capita availability of pulses, reducing import dependence and to some extent it will stabilize the pulse prices.

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